THE AUSTRALIAN WORK EXPOSURE STUDY (AWES):
CARCINOGEN EXPOSURES IN THE CONSTRUCTION INDUSTRY

Report

May 2016

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CARCINOGEN EXPOSURES IN THE CONSTRUCTION INDUSTRY

MAY 2016

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PREFACE

The Australian Work Health and Safety Strategy 2012–2022 (the Strategy) describes the construction industry as a priority industry for prevention activities 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 collected information from respondents about their activities in the workplace and the controls used. This information was then used to estimate possible and probable exposures among respondents to 38 agents classified by the International Agency for Research on Cancer (IARC) as known or suspected carcinogens.

This report, prepared in collaboration with Safe Work Australia, uses AWES data to:

- estimate carcinogenic exposures within the construction industry
- identify the main circumstances of those exposures, and
- describe the reported use of workplace controls and protective measures designed to decrease those exposures.

The report describes those exposures that occur during typical work activities carried out by AWES respondents who were categorised as working in construction and does not specifically focus on high risk workers.

SUMMARY

Why has this research been done?

The aim of this research is to improve our understanding of workers' potential exposure to 38 known or suspected carcinogens likely to be used in Australian workplaces.

While most workers will not develop cancer as a result of work-related exposures, those exposed to known or suspected carcinogens are at greater risk.

Who did we study?

A random, population-based sample of 5528 Australian workers participated in the Australian Work Exposure Study (AWES). Workers answered questions about the tasks they completed and the controls that were used at work. Based on their responses to those questions, the likelihood of exposure to 38 carcinogens was estimated.

This report focuses on the 459 AWES respondents who were categorised as working in the construction industry.

The AWES provides representative information about potential carcinogen exposures from relatively common activities. However, the results presented in this report should not be considered an exhaustive list of potential exposures to carcinogens in the construction industry.

What did we find?

Most construction workers in this study (96 per cent) were estimated to have a probable exposure to at least one carcinogen and just over half (53 per cent) were estimated to have probable exposures to at least four carcinogens.

The most common carcinogens to which workers were probably exposed were solar ultraviolet (UV) radiation (86 per cent), environmental tobacco smoke (59 per cent), crystalline silica (38 per cent), diesel engine exhaust (37 per cent), wood dust (36 per cent) and lead (24 per cent).

Common exposure circumstances included outdoor work (solar UV radiation), working near someone smoking (environmental tobacco smoke), and working near operating diesel-powered engines.

The main tasks associated with probable exposure included working with wood, mixing concrete or cement, painting preparation, soldering and welding, and refuelling vehicles.

The reported use of controls to prevent or minimise exposures varied considerably by task and circumstance, and was considered adequate about 7 per cent of the time for outdoor workers exposed to solar UV radiation and 63 per cent of the time for painters engaged in certain aspects of painting preparation work.

What do the findings suggest?

Existing work health and safety (WHS) guidance provides information about potential health effects and how exposures might occur and be prevented. However, the results from this study suggest that the use of controls could be improved when a number of common tasks are carried out.

What can be done?

As a first step, preventative actions should be focused on the most common carcinogen exposures and those for which options for preventing or minimising exposures are well known. In construction, this suggests a focus on reducing exposures to diesel engine exhausts and solar UV radiation, increasing the enactment and enforcement of workplace smoking bans, and encouraging more frequent use of ventilation systems and respiratory protective equipment where dusts and fumes are generated—i.e. for tasks like welding, soldering or carpentry.

Existing WHS information could be better tailored or organised for the construction industry. For example, WorkCover Queensland has published task-specific web-based guidance for the removal of lead based paint.

Key results could be validated through additional and more direct exposure measurement studies. The AWES exposure estimates are based on inferences made from information provided by respondents about the manner in which they perform tasks at work, using rules developed by Australian occupational hygienists. Respondents were not directly asked about their exposure to known or suspected carcinogens.

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EXECUTIVE SUMMARY

Background

The construction industry has been identified as a priority industry for prevention activities under the Australian Work Health and Safety Strategy 2012–2022 (the Strategy). Under this strategy, better understanding of current hazardous exposures and the effectiveness of controls is a research priority. The construction industry comprises many different types of workplaces and work tasks which might expose construction workers to a wide variety of carcinogenic (cancer causing) agents. However, little is known about the prevalence of exposure to carcinogens or the tasks which may lead to these exposures within the Australian construction industry.

The Australian Work Exposures Study (AWES) was a national survey conducted between 2011 and 2013 that investigated work-related exposures to 38 known or suspected carcinogens among Australian workers. This data set provides an opportunity to gain a better understanding of the extent and circumstances of exposure to carcinogens among construction workers.

The aim of this report was to estimate the prevalence of exposure to carcinogens among construction workers, to identify the main circumstances of those exposures, and to describe the use of workplace controls designed to decrease those exposures. This report describes those exposures that occur during typical work activities carried out by AWES respondents who were categorised as working in the construction industry, and does not specifically focus on high risk workers.

Approach

The information presented in this report comes from analyses of data from AWES. This study involved computer-assisted telephone interviews of approximately 5500 Australian workers. Similar to expert assessment methods, workers answered questions about the tasks they completed and the controls that were used at work. Based on their responses to those questions, the likelihood of exposure to 38 carcinogens (and exposure levels) was estimated. As AWES was a large scale survey attempting to estimate exposure to multiple agents in multiple workplaces, the online application OccIDEAS (Fritschi, Friesen et al. 2009) was used to estimate exposures, using algorithms based on determinants of exposure identified in the published literature and supplemented by expert knowledge. All assessments were subsequently reviewed by AWES researchers and the adequacy of control measures reported by respondents was assessed by hygienists. For this report, data on tasks that could result in worker exposures in the construction industry were extracted and examined. Tasks completed by nine or more respondents were examined in greater detail.

Key findings

A total of 459 respondents in the AWES survey were categorised as being employed in the construction industry. Of these, 441 (96%), were estimated to have a probable exposure to at least one carcinogen. There were 19 carcinogens to which at least one respondent was estimated to have probable exposure and 15 carcinogens to which nine or more construction workers were probably exposed. Most construction workers were estimated to be probably exposed to several carcinogens, with 53% of workers probably exposed to four or more carcinogens. The most prevalent exposures were:

- solar UV radiation (solar UV; 86% exposed)
- environmental tobacco smoke (ETS; 59%)
- crystalline silica (38%)
- diesel engine exhaust (DEE; 37%), and
- wood dust (36%).

Workers could be exposed to these carcinogens in a variety of ways. Common exposure circumstances included:

- outdoor work (solar UV radiation exposure)
- working in the vicinity of someone smoking (ETS exposure), and
- working in the vicinity of operating diesel-powered engines (DEE).

The main tasks associated with probable exposure included:

- working with wood (wood dust, formaldehyde and chromium VI exposure)
- mixing concrete or cement (crystalline silica exposure)
- painting preparation (wood dust, lead, formaldehyde and chromium VI exposure)
- soldering (lead exposure)
- welding (chromium VI , nickel and polycyclic aromatic hydrocarbons other than vehicle exhaust [other PAHs] exposure), and
- refuelling vehicles (benzene exposure).

These findings help confirm what is known or suspected about typical exposures to carcinogens in construction.

Reported use of control measures was, on the whole, limited in construction workers. Where information on controls was collected, the reported use of controls to prevent or minimise exposures varied considerably by task and circumstance, and was considered adequate about 7% of the time for outdoor workers exposed to solar UV radiation to 63% of the time for painters engaged in certain aspects of painting preparation work.

Limitations

AWES is a national population-based study which is able to capture exposures across a wide range of workers and provide representative information on relatively common activities. However, this methodology is unable to provide information on tasks specific to a particular construction occupation which are less common or are undertaken by a relatively small number of people. Such information would require a targeted research project to be undertaken. The AWES used a telephone survey to collect data and thus was subject to time constraints. A compromise was needed between covering the essential questions and including questions that are important but not required for the primary purpose of the study. This meant that a limited number of specific questions could be asked about any particular circumstance. In addition, the questions asked on control use were limited to those circumstances that would affect the exposure assessment.

Exposure assessments were qualitative and refer to task or activity based exposure levels. This means that they do not necessarily correlate to exposure standards and are not an assessment of the time-weighted average exposure of that person. 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.

Exposure estimates have not been validated against measured exposures and they should not be used to comment on current cases of work-related cancer. Occupational cancers are caused by past exposures and often there can be a period of many decades between exposure to a carcinogen and subsequent disease incidence—that is current exposures will not provide information to help understand the causes of current cancer cases. Information about current exposures more appropriately enables work health and safety policies and practices to be revised or developed in a timely manner to prevent future cancer cases.

Potential implications

Approximately 96% of AWES respondents who worked in the construction industry were estimated to be probably exposed to at least one carcinogen when performing relatively common activities at work. While most of these workers will not develop cancer as a result of work-related exposures, they are at greater risk. Quantifying those risks is not straightforward and as a result, information is not readily available. Reviewing and assessing existing literature to derive such estimates was beyond the scope of this report. Focus for additional preventative action should be based on a balance between the exposures with a high prevalence and the exposure circumstances for which there are proven control measures and that are most amenable to control. For the construction industry, this suggests:

- using new generation diesel engines (lower emissions technology), regular maintenance of existing diesel-powered vehicles and equipment, installation and maintenance of filter systems (trap particulate matter), and implementing work practices that minimise the time spent by workers near operating diesel engines
- widespread adoption (enactment of relevant anti-smoking legislation in those jurisdictions yet to do so) and enforcement of workplace smoking bans
- regularly using local exhaust ventilation (or carrying out activities in well-ventilated areas) and respiratory protective equipment (RPE) where workers are likely to be exposed to wood dust
- regularly using local exhaust ventilation (or carrying out activities in well-ventilated areas) and RPE designed for welding or soldering tasks, and
- increasing the use of all sun protection measures—working in the shade, wearing protective clothing that covers up arms and legs, wearing a hat and using sunscreen.

Although there is some information available in the literature about the health effects, exposures and control of the carcinogens found in the construction industry, this information is not organized in a way which is readily accessible—in form and content—for the construction industry. There is a need for clear, concise and consistent information on the circumstances and control of exposures that is specifically tailored to the construction industry.

Further research

The AWES provides information on current exposures to carcinogens within the construction industry. Measuring specific carcinogen exposures in the workplace may be of potential use in validating the AWES data. There was no scope to complete this task as part of the AWES.

The work presented in this report could also be complemented by the collection of additional information about the use of controls to prevent exposures where nine or more AWES respondents were estimated to have probable carcinogenic exposures. Further research could also help understand why appropriate control measures are not being used and how to use this knowledge to improve current measures and workplace practice.

The potential burden of these exposures in terms of future cancer risk in construction workers can be estimated. A method of predicting future cases of cancer due to current exposures has been used to help understand the potential burden of work-related cancer in the UK. This method could be used with Australian exposure data for example, AWES data, to predict the number and type of future work-related cancers in Australia and to help identify work health and safety intervention priorities.

BACKGROUND

Introduction

The construction industry comprises many different types of workplaces and work tasks, and a range of exposures.

Data from the recent Australian Work Exposures Study (AWES) provides an opportunity to gain a better understanding of the extent and circumstances of exposure to carcinogens (cancer-causing agents) among workers in the Australian construction industry.

The aim of this report was to use AWES data to estimate the prevalence of exposure to carcinogens among construction workers, to identify the main circumstances of those exposures, and to describe the use of workplace controls designed to prevent or minimise those exposures. This is followed by a consideration of the potential implications of these results for exposure prevention.

This report presents information on estimated exposures to carcinogens among AWES respondents categorised as construction workers.

This report presents information on estimated exposures to carcinogens among AWES respondents categorised as construction workers. Exposure estimates have not been validated against measured exposures and they should not be used to comment on current cases of work-related cancer. Occupational cancers are caused by past exposures and often there can be a period of many decades between exposure to a carcinogen and subsequent disease incidence—that is current exposures will not provide information to help understand the causes of current cancer cases. Information about current exposures more appropriately enables work health and safety policies and practices to be revised or developed in a timely manner to prevent future cancer cases.

The Australian construction industry

In 2014, the construction industry employed about 9% of all people employed in Australia (ABS 2012). The construction industry added a gross value of $102 billion and contributed eight per cent to Australia's gross domestic product in 2010–11. The largest sub-sectors within the industry were Construction Services (695,000; 67%) and Building Construction (231 000; 22%) (ABS 2012).

Cancer in the construction industry

Studies show that there are some cancers to which the construction industry has been linked, including lung cancer, mesothelioma, sinonasal cancer, and non-melanoma skin cancer (Consonni et al. 2015; Järvholm & Englund 2014; Pukkala et al. 2009; Rushton et al. 2010; Rushton et al. 2012).

Industry exposure to carcinogens

The construction industry comprises many different types of workplaces and work tasks, and a range of exposures. Construction workers have been identified in many studies of being at risk of exposure to a number of carcinogens (Hutchings et al. 2012; Rushton et al. 2010), particularly asbestos (Consonni et al. 2015), crystalline silica (Consonni et al. 2015), solar UV radiation (Boniol et al. 2015) and diesel engine exhaust (Rushton et al. 2010).

Previously collected information on exposures and control measures in Australia

The construction industry was identified as having the highest prevalence of potential exposure to wood and related dust

The National Hazard Exposure Worker Surveillance (NHEWS) survey, a study of Australian workers designed to examine the frequency of exposure to a range of hazards, was conducted in 2008. The construction industry was identified as having the highest prevalence of potential exposure to wood and related dust (30%), acids and alkalis (35%) and dusts from processed materials (17%) and to have high prevalence of potential exposure to direct sunlight (60%); "dust" (concrete and cement, wood dust, "environmental dust" and "road dust") (65%); and gases, vapours, smoke or fumes (23%). The prevalence of potential exposure to "chemicals" was (44%), with the most common chemicals being solvents, paints or glues, cement and cleaning products. Construction workers in the NHEWS study had the longest reported exposure to chemicals in terms of hours per week; and a high prevalence of dermal exposure to cement and lime, to paints, varnishes and inks, to organic solvents and to non-bituminous hydrocarbon fuels (MacFarlane et al. 2012). NHEWS respondents often provided multiple responses to questions about the provision of controls, with some of the most commonly provided being masks, ventilation systems, gloves and protective clothing. The NHEWS study used self-reported exposures which have been found to lead to significant misclassification when compared with expert assessment (Safe Work Australia 2009).

Previously collected information on exposure and control measures in other countries

Construction workers have been identified in many other studies as being at risk of exposure to a number of carcinogens, particularly asbestos, crystalline silica, solar UV radiation and diesel engine exhaust. CAREX Canada identified the most common exposures in the construction industry in Canada as solar UV radiation, crystalline silica, wood dust, asbestos, and diesel engine exhaust (CAREX Canada 2012).

Cancers caused by workplace carcinogens

The International Agency for research on Cancer (IARC) provides information on the cancer sites associated with carcinogenic agents (Cogliano et al. 2011; IARC 2015). Some common carcinogens associated with the construction industry and cancer sites they have been associated with are outlined in Table 1.

Table 1: List of carcinogens common in the construction industry and their associated cancer sites

Carcinogens	Cancer sites with sufficient evidence in humans	Cancer sites with limited evidence in humans
Asbestos	Mesothelioma, lung, larynx, ovary	Colon, rectum, stomach
Benzene	Leukaemia (acute non-lymphocytic)	Leukaemia (acute lymphocytic, chronic lymphocytic, multiple myeloma, non-Hodgkin lymphoma)
Chromium (VI) compounds	Lung	Nasal cavity and paranasal sinus
Engine exhaust, diesel		Lung; urinary bladder
Formaldehyde	Leukaemia (particularly myeloid), nasopharynx	Nasal cavity and paranasal sinus
Lead compounds, inorganic		Stomach
Nickel compounds	Lung; nasal cavity and paranasal sinus	
Silica dust, crystalline (in the form of quartz or crystobalite)	Lung	
Solar UV radiation	Skin (basal cell carcinoma, squamous cell carcinoma, melanoma)	Eye (squamous cell carcinoma, melanoma); lip
Tobacco smoke, second-hand	Lung	Larynx; pharynx
Trichloroethylene	Renal cancer	Liver and biliary tract; non-Hodgkin lymphoma
Wood dust	Nasal cavity and paranasal sinus; nasopharynx	

Note: The IARC did not differentiate between types of wood when classifying “wood dust” as carcinogenic so all types of wood dust were included in the AWES.

Sources: Cogliano et al. 2011 and IARC 2015

Information on control measures

There are a range of exposure control measures that are used or have been recommended to control carcinogenic exposures in the construction industry. These cover all aspects of the hierarchy of control—elimination, substitution, isolation, engineering controls, administrative approaches and personal protective equipment (PPE). The specific measures used depend on the nature of the hazard, the tasks in which the exposure may occur and consideration of what is reasonably practicable. In many cases, exposures are likely to occur by inhalation of airborne contaminants. For inhalation exposures which cannot be eliminated, the hierarchy of controls must be used to minimise risks (exposures) so far as is reasonably practicable—by substituting hazards (chemicals or work processes used) with something that poses less risk, isolating hazards from workers and others in the workplace, or by using or introducing engineering such as local and area ventilation. Where risks still remain, administrative policies—designed to reduce the amount of time performing tasks or working in areas where exposures may occur—must be implemented, so far as is reasonably practicable, before PPE, including respiratory protective equipment (RPE) such as air-supplied helmets or face masks, is provided. These control measures are considered in more depth later in this report in relation to specific tasks or activities which were identified as resulting in probable exposures to carcinogens.

METHODS

The analysis presented in this report is based on data from the AWES (Carey et al. 2014b), and supplemented with data from the Australian Work Exposures Study—Western Australia (AWES-WA). Both were telephone-based surveys investigating current occupational exposure to 38 known or suspected carcinogens among Australian workers.

Selection of carcinogens

The 38 carcinogens had been prioritised in 2012 as being those most relevant to Australian working conditions (Fernandez et al. 2012).

The selection process began by collating all agents classified by the IARC as either: carcinogenic to humans (Group 1) or probably carcinogenic to humans (Group 2A). While several classifications of carcinogens are available, the IARC classification was chosen because it had been used in other similar studies (Kauppinen et al. 2000; Rushton et al. 2012). From the initial list the following were excluded:

- exposure circumstances, for example working as a painter
- agents for which exposure is not primarily occupational such as dietary, pharmaceutical, or infectious agents, and
- those not used in Australia, for example, banned substances or those not on the Australian Inventory of Chemical Substances (NICNAS 2015).

The AWES sample

The sample for AWES was obtained from a commercial survey sampling firm and consisted of household contact details sourced from various public domain directories. Both landline and mobile phone numbers were included and the sample was stratified to approximate the distribution of the Australian work force by state and territory as reported by the ABS (ABS 2011b). Within these households, all residents aged between 18 and 65 and currently working were eligible to participate. Those with insufficient English speaking ability and those who were deaf or too ill to participate were ineligible. One eligible person within each household was selected for interview.

Data from this study were combined with data from the AWES-WA. This study collected information on a further 505 Western Australian residents using the AWES methodology.

In total, 22 590 households were telephoned. No response was obtained from 3033 households, while 12 081 were ineligible and 1948 refused to participate. A total of 5528 interviews were completed, resulting in a response rate (excluding ineligible households) of 53%.

The AWES studies were population-based surveys, where participants were randomly selected from the working age population.

The AWES studies were population-based surveys, where participants were randomly selected from the working age population. Thus, participants were recruited from a wide range of occupations and industries rather than being selected from specific industries. In some industries the number of participants may be small but should reflect the general working population in that industry.

Exposure assessment methods

The online application OccIDEAS (Fritschi et al. 2009) was used to categorize people as to whether they were exposed to the 38 carcinogens. This application is based on the expert assessment method in which questions about tasks are asked of the worker, and experts infer the worker's exposure from that information (Siemiatycki et al. 1981). The innovative feature of OccIDEAS is that it uses algorithms to automatically assign exposure. The algorithms are based on determinants of exposure identified in the published literature and supplemented by expert knowledge. For example, a worker who reported welding stainless steel using oxyacetylene processes would be assigned high level exposure (that is control measures are likely to be needed) if welding inside and neither an air-supplied welding helmet nor a ventilation system was used.

The OccIDEAS approach provides an estimate of exposure rather than an actual measurement.

The OccIDEAS approach provides an estimate of exposure rather than an actual measurement. However it can be used in large scale surveys such as AWES in which there is no possibility of measuring exposure to multiple agents in multiple workplaces. OccIDEAS is being used in several studies around the world including AsiaLymph (National Cancer Institute 2015) and the Australian Mesothelioma Registry (AMR 2015).

The OccIDEAS approach relies on the worker reporting their tasks accurately. While this may not always be the case, it is usually better than relying on the worker to assess their own exposure such as was used in surveys such as NHEWS (Safe Work Australia 2009; Teschke et al. 2002).

Data Collection

Interviews were conducted between October 2011 and September 2013 by trained interviewers using computer-assisted telephone interviews. All respondents provided oral informed consent before providing any information.

Demographic information collected included age, gender, postcode of residence, country of birth, year of arrival in Australia, language spoken at home, and highest level of education. Postcode information was used to determine workers' socioeconomic status (ABS 2008) and remoteness (ABS 2011a).

A simple screening tool was then used to classify each respondent's main job as either exposed or unexposed to any of the 38 carcinogens. Those whose job fitted into one of 13 predetermined categories of unexposed jobs, for example white-collar professional or customer service workers, were categorised as unexposed and the interview completed. A total of 2783 respondents were classified as unexposed at this point.

Basic job information, including job title, main tasks completed, industry, and frequency of work in terms of hours per week and weeks per year, was collected

Basic job information, including job title, main tasks completed, industry, and frequency of work in terms of hours per week and weeks per year, was collected from the remaining 2745 respondents. This information was then used to assign respondents to one of 57 job specific modules (JSMs) in OccIDEAS. Specific JSMs were completed by 2649 respondents. For the remaining 116 respondents open-ended questions were used to collect information about the respondent's day-to-day job tasks. Each complete interview took approximately 15 minutes.

Job coding

Following the interviews, each of the jobs was coded according to the Australian and New Zealand Standard Classification of Occupations (ANZSCO) (ABS 2006b) and the Australian and New Zealand Standard Industrial Classification (ANZSIC) (ABS 2006a). The analysis presented in this report is restricted to 459 AWES respondents who were categorised as working in the Construction Industry (ANZSIC code 'E').

The Construction Industry ANZSIC code 'E' comprises the following subgroups;

- Building Construction
- Heavy and Civil Engineering Construction and
- Construction Services.

AWES construction worker demographical information

The AWES construction workers were predominantly male (99%), Australian born (80%), not university educated (89%), from major cities (61%) or inner regional areas (27%), and of middle to high socioeconomic status (82%). The mean age of workers was 45 years (standard deviation = 12 years). Other demographic information and a comparison to all construction workers is provided at Appendix 1.

The majority of construction workers were technicians and trades workers (63%), with most of the remainder being labourers (19%) and machine operators and drivers (10%).

Exposure assessments

OccIDEAS was used to provide an automatic assessment of the probability ('none', 'possible', 'probable') and level ('unknown', 'low', 'medium', 'high') of exposure to each of the 38 carcinogens. These assessments were based on predetermined rules which had been developed on the basis of findings reported in the scientific literature, including exposure measurements where relevant, and expert opinion. Rules were attached to and triggered by specific answers within the JSMs and took into account the tasks completed, materials used and the use of exposure control measures, where this information was available. All automatic assessments were reviewed by project staff for consistency.

Possible exposures were assigned if the information suggested there was a chance the respondent could be exposed but not enough information was available to accurately estimate whether they were exposed or not. Probable exposures were assigned where it was likely the respondent was exposed.

Assigned exposure levels provide an estimate of exposure for specific tasks taking into account task-related factors including the adequacy of workplace controls which could eliminate or reduce exposures, based on information reported by respondents—they are not an assessment of time-weighted average exposure and they do not necessarily correlate to exposure standards. Thus, a low level of exposure was defined as 'present but not likely to require further control measures'; high exposure as 'control measures are likely to be needed'; and medium as a level between these values (Figure 1) (Fritschi et al. 2012). This information is designed to highlight circumstances where the use of controls can be improved rather than attempt to estimate the risk of cancer arising from specific tasks.

Figure 1: Automatic assessment definitions for OccIDEAS

OccIDEAS was used to provide an automatic assessment of:

probability

- ***none***
- ***possible**—'the information suggests there is a chance that the person could be exposed but there is not enough information available to correctly determine whether they are exposed or not', or*
- ***probable**—'it is likely that this person is exposed', and*

level

- ***unknown***
- ***low**—'present but not likely to require further control measures*
- ***high**—'control measures are likely to be needed', or*
- ***medium**—level between these values.*

Statistical Analysis

All statistical analyses were conducted using Microsoft Excel. Descriptive statistics were used to summarise the demographic distribution of the sample. The sample distribution was then compared with the demographic distribution in the Australian working population employed in the construction industry according to Census 2011 data (ABS 2011b).

Overall prevalence of exposure was defined as the proportion of respondents assessed as having probable exposure to at least one of the priority carcinogens in their current job, regardless of frequency, duration, or level of exposure. A dichotomous measure of exposed or not exposed was used. Prevalence of exposure to individual carcinogens was similarly defined as the proportion of respondents assessed as having probable exposure to that carcinogen. Further analyses were restricted to those carcinogens to which nine or more workers were probably exposed.

Confidence intervals are not included in this report because calculations would have been very difficult to undertake accurately given the multi-stage sampling methods used, and more error is likely to arise from selection and measurement issues than from the statistical uncertainty implied by confidence intervals and probability values. Including uncertainty statistics would make the report less readable while providing little additional useful information for general audiences.

Task-based Analysis

Task-based analyses were restricted to those carcinogens with nine or more workers assessed as being probably exposed. For each such carcinogen, a list of potential circumstances leading to exposure was compiled, and the number of respondents completing each task counted. Only those tasks completed by nine or more respondents were subject to further analysis. For each relevant task, the number of respondents completing the task was cross-tabulated with the exposure level assigned.

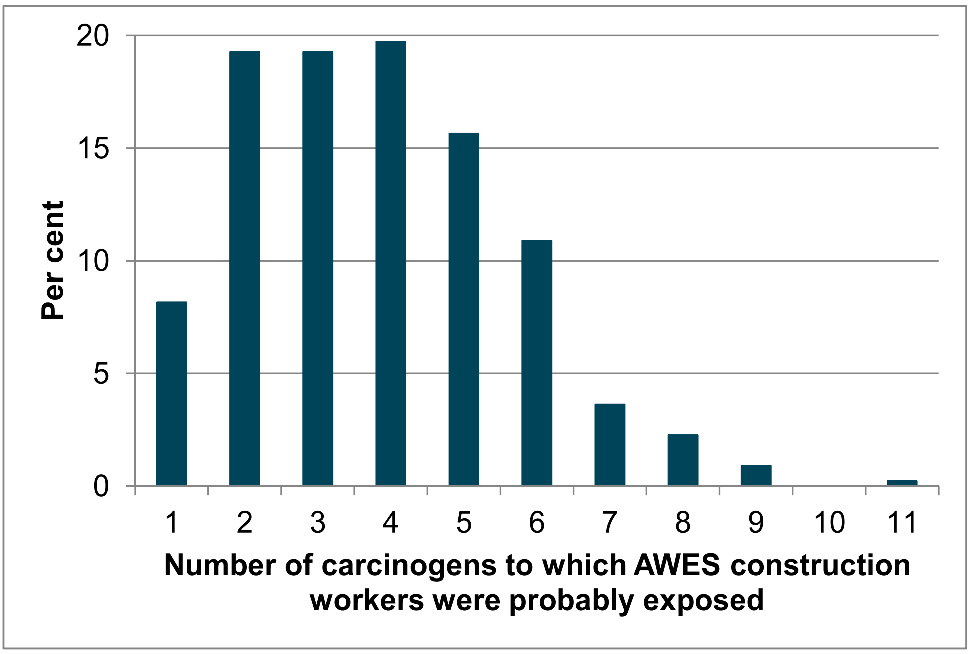
Where available, the use of controls, including personal protective equipment was also considered for each task. A cross-tabulation was used to compare the number of respondents completing each task with the number who reported using the controls included in JSMs.

RESULTS: Information on exposure and control measures from the Australian Work Exposure Study

Overall results

A total of 441 (96%) of the construction workers were estimated (or deemed) to have probable exposure to at least one carcinogen. Most workers were estimated to have a probable exposed to several carcinogens, with 53% of workers estimated to have a probable exposure to four or more carcinogens (Figure 2).

Figure 2: Number of carcinogens to which AWES construction workers were deemed to have probable exposure



There were 19 carcinogens to which at least one of the construction workers was estimated to be either probably or possibly exposed. The carcinogens that had the highest prevalence of probable exposure in the construction industry were solar UV radiation (86%), environmental tobacco smoke (ETS; 59%), crystalline silica (38%), diesel engine exhaust (DEE; 37%) and wood dust (36%) (Table 2 and Figure 3).

Table 2: AWES construction workers estimated to have probable or possible exposure to carcinogens—by carcinogen [number (per cent)]

Carcinogen	Probable exposure n (%)	Possible exposure n (%)	Total n (%)
Solar UV radiation*	**396 (86)**	**0**	**396 (86)**
ETS*	**272 (59)**	**0**	**272 (59)**
Silica*	**174 (38)**	**1 (0)**	**175 (38)**
Diesel engine exhaust*	**172 (37)**	**0**	**172 (37)**
Wood dust*	**163 (36)**	**5 (1)**	**168 (37)**
Lead*	**112 (24)**	**72 (16)**	**184 (40)**
Chromium VI*	**82 (18)**	**50 (11)**	**132 (29)**
Formaldehyde*	**68 (15)**	**5 (1)**	**73 (16)**
Benzene*	**66 (14)**	**1 (0)**	**67 (15)**
Other PAHs*	**34 (7)**	**0**	**34 (7)**
Arsenic*	**26 (6)**	**0**	**26 (6)**
Nickel*	**19 (4)**	**17 (4)**	**36 (8)**
Trichloroethylene*	**19 (4)**	**2 (0)**	**21 (5)**
Asbestos*	**17 (4)**	**183 (40)**	**200 (44)**
Ionising radiation*	**10 (2)**	**0**	**10 (2)**
Shift work	8 (20)	0	8 (2)
Artificial UV	5 (1)	62 (14)	67 (15)
Acid mist	3 (1)	0	3 (1)
Cadmium	1 (0)	15 (3)	16 (3)

Notes:

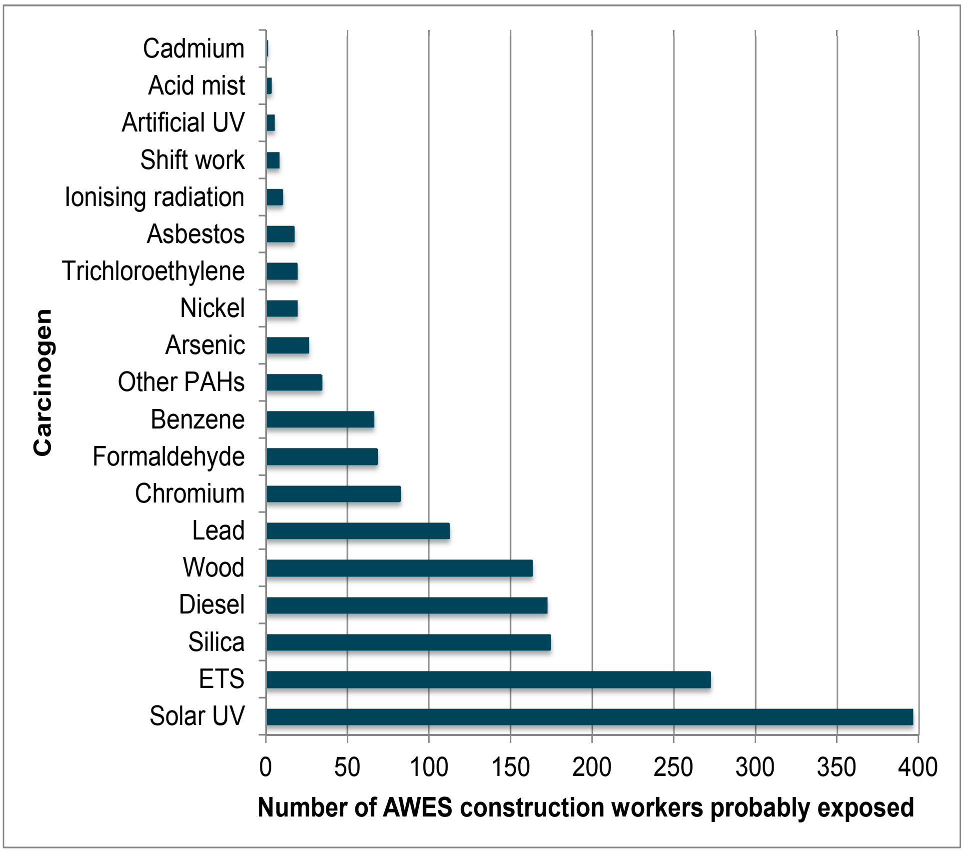
Those that are bold and have an * are those in which nine or more respondents were probably exposed and will be the only carcinogens included in further analysis.

ETS—environmental tobacco smoke

Other PAHs—polycyclic aromatic hydrocarbons (PAHs) other than vehicle exhaust

UV—ultraviolet radiation

Figure 3: Carcinogens to which AWES construction workers were deemed to have probable exposure



Exposure combinations

The most prevalent estimates of exposures were to solar UV radiation, ETS, silica, DEE and wood dust. Focusing only these carcinogens, 21 construction workers were deemed to have probable exposure to all five while 161 workers had exposure to four of these five carcinogens. A range of occupations were identified with exposure combinations. For example, 78 respondents were deemed to have probable exposures to formaldehyde and wood dust (mainly carpenters), 26 respondents were deemed to have probable exposure to arsenic, chromium VI and wood dust (all carpenters), 15 respondents were deemed to have probable exposures to chromium VI, lead and nickel (mainly plumbers and construction workers), and 20 respondents were deemed to have probable exposures to chromium and nickel (mainly plumbers, particularly in association with welding).

The rest of this chapter separately considers each of the exposures to which nine or more workers were deemed to have probable exposure. This is set out in alphabetical order as done in the Model WHS Regulations (Schedule 10) (Safe Work Australia 2014) and Safe Work Australia guidance for health monitoring (Safe Work Australia 2013b).

Arsenic

Twenty-six (6%) workers were deemed to have a probable exposure to arsenic. Of those exposed, 8% were exposed at a medium level and 92% at a low level.

Circumstances of exposure

All workers deemed to have probable exposures to arsenic were carpenters or builders who were exposed to arsenic contained in wood preservatives. Most (92%) respondents worked with wood treated with preservative and were assigned a low level exposure but some (8%) also applied the preservative which was assigned a medium level exposure.

Information on the use of controls was not collected for tasks associated with probable exposure to arsenic.

Asbestos

Seventeen (4%) workers were deemed to have a probable exposure to asbestos. Of those exposed, 6% were exposed at a high level, 29% at a medium level and 65% at a low level.

The workers were most commonly machinery operators (53%) and technicians and trades workers (18%).

Circumstances of exposure

The most common (53%) probable exposure to asbestos was through servicing of brakes which was assigned a low level exposure. However, the age of the machinery or vehicle was not ascertained and machinery or vehicles built after 2003 should be asbestos free. A small number of workers were deemed to have a probable exposure through installing, disturbing or removing materials containing asbestos, driving trucks disposing of asbestos waste or sweeping sites where asbestos had been used (Table 3).

Table 3: Main circumstances resulting in probable exposure to asbestos

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Maintenance on vehicle brakes	-	-	9	9
Installing, disturbing or removing materials containing asbestos	1	3	-	4
Driving trucks carting asbestos waste	-	-	2	2
Unloading or loading asbestos waste	-	-	2	2
Sweeping sites where asbestos was used	-	1	-	1
Asbestos removal	-	1	-	1

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

The use of controls

Information on the use of controls was not collected for tasks associated with probable exposure to asbestos.

Benzene

Sixty-six (14%) workers were deemed to have a probable exposure to benzene. Of those exposed, all but one was assigned a medium level exposure and the other was assigned a high level exposure.

The workers were most commonly technicians and trades workers (47%), labourers (23%) and managers (11%).

Circumstances of exposure

Most (n=54, 82%) workers were deemed to be exposed when refuelling petrol vehicles or equipment powered by petrol motors. Seven (11%) respondents were exposed through degreasing with petrol at room temperature (Table 4).

Table 4: Main circumstances resulting in probable exposure to benzene

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Refuelling vehicles	-	54	-	54
Degreasing with petrol	-	7	-	7
Other	1	4	-	5

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

The use of controls

Information on the use of controls was not collected for tasks associated with probable exposure to benzene.

Chromium VI

Eighty-two (18%) workers were deemed to have a probable exposure to chromium VI. Of those exposed, 12 (15%) were assigned a high level exposure, 10 (12%) were assigned a medium level exposure and 60 (73%) were assigned a low level exposure.

The workers were most commonly technicians and trades workers (79%) and labourers (17%).

Circumstances of exposure

The main tasks in which construction workers were deemed to have probable exposures to chromium VI were carpenters working with wood treated with preservatives containing chromium compounds (33%), mostly assigned medium level exposure; welding (32%), assigned high level exposure if the reported use of controls was considered inadequate, otherwise assigned medium or low level exposure; painters burning paint containing zinc chromate (24%), assigned medium level exposure if the use of respiratory protective equipment was not reported and low exposure if it was; and concreting (11%) (Table 5).

The use of controls

Limited information was collected on the use of controls for tasks associated with probable exposure to chromium VI. Information was available for 17 workers who welded. Of these workers, 41% used a welding booth more than 50% of the time, 59% welded outside more than 50% of the time and 13% regularly used an air supplied welding helmet, however, one worker (6%) reported welding in a confined space without appropriate respiratory protection. Of the 20 workers who burned off paint, 85% used some form of respiratory protection.

Table 5: Main circumstances resulting in probable exposure to chromium VI

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Carpenters working with preserved wood	-	25	2	27
Welding	11	4	11	26
Painters—burning off paint	-	3	17	20
Concreting	-	-	9	9

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

Crystalline silica

One hundred and seventy-four (38%) workers were deemed to have a probable exposure to crystalline silica (one had possible exposure). Of those exposed, 67% were assigned a high level exposure, 13% a medium level exposure and 20% a low level exposure.

The workers were most commonly technicians and trades workers (41%), labourers (32%) and machine operators and drivers (18%).

Circumstances of exposure

Construction workers were probably exposed to silica during several tasks. The most common were working with concrete or cement (60%), all assigned high level exposure; and building or renovating buildings (43%), all assigned low level exposure. Low level exposures were assigned to those that worked on construction sites who were not undertaking tasks related to higher exposures—that is they were exposed to 'background levels' only. Other common activities included road construction (9%), a mixture of low and high level exposures for tasks such as ground construction or preparing road surfaces for paving, road paving or sealing and road sweeping; material handling (7%); and working with plaster (5%) (Table 6).

Table 6: Main circumstances resulting in probable exposure to crystalline silica

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Concrete or cement	104	-	-	104
Building or renovating	-	-	75	75
Road construction	8	7	-	15

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

The use of controls

Information on the use of controls was not collected for tasks associated with probable exposure to crystalline silica.

Diesel Engine Exhaust (DEE)

One hundred and seventy-two (37%) workers were deemed to have a probable exposure to DEE. Of those exposed, 12% were assigned a high level exposure, 47% a medium level exposure and 41% a low level exposure.

The workers were most commonly technicians and trades workers (45%), machine operators and drivers (22%) and labourers (17%).

Circumstances of exposure

The location (whether indoors, outdoors, or both), distance from the vehicle, and the presence of exhaust smell were all factors that influenced the assigned exposure level

The location (whether indoors, outdoors, or both), distance from the vehicle (less than 20 metres, 20–50 metres, more than 50 metres) and the presence of exhaust smell were all factors that influenced the assigned exposure level. Higher exposure levels were assigned to those who worked indoors, closer to vehicles, and could smell exhaust fumes. The exposures occurred when working near diesel-powered vehicles (60%), using diesel-powered pumps (12%), driving diesel-powered vehicles (9%), undertaking maintenance of vehicles with diesel engines (8%), and working near a diesel-powered generator (4%) (Table 7). There were no particular occupations involved in undertaking the tasks resulting in these exposures.

Table 7: Main circumstances resulting in probable exposure to DEE

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Working near where diesel engines were operating	2	51	50	101
Operating diesel powered pumps		9	12	21
Driving diesel-powered vehicle	2	9	4	15
Vehicle maintenance	3	6	5	14
Working near diesel generator	1	3	3	7

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

The use of controls and protective equipment

Information on the use of controls was not collected for tasks associated with probable exposure to DEE.

Environmental tobacco smoke (ETS)

Two hundred and seventy-two (59%) workers were deemed to have a probable exposure to environmental tobacco smoke (ETS). Of those exposed, 26% were assigned a high level exposure and 74% a low level exposure.

The workers were most commonly technicians and trades workers (63%), labourers (18%) and machine operators and drivers (12%).

Circumstances of exposure

Of all construction workers, 15% were assigned high level exposure to ETS because other workers smoked indoors when respondents were working in the vicinity. Another 44% were assigned low exposure to ETS because other workers smoked at the entrance to the workplace or in outdoor areas when the respondent was working in the vicinity.

Overall, worksite bans were reported by 156 (57%) of the construction workers who were deemed to have a probable exposure to ETS.

Overall, worksite bans were reported by 156 (57%) of the construction workers who were deemed to have a probable exposure to ETS. Noting multiple responses could be provided, these bans covered indoor areas (56% of exposed workers deemed to have a probable exposure), entrances to buildings (30%), outdoor areas (20%), or the whole worksite (17%).

When individual exposure scenarios were examined, the proportion of construction workers reporting working bans were in place varied. Of the construction workers who were deemed to have a probable exposure to ETS when working in indoor areas, 45% reported workplace bans against indoor smoking were in place. Of those exposed at entrances to workplaces, 26% reported having a ban against smoking at entrances in place. Of those exposed when working in outdoor areas, 19% reported having a ban against smoking in outdoor areas in place.

Formaldehyde

Sixty-eight (15%) workers were deemed to have a probable exposure to formaldehyde. Of those exposed, 54% were assigned a medium level exposure and 46% a low level exposure.

The workers were most commonly technicians and trades workers (72%) and labourers (22%).

Circumstances of exposure

The main exposure circumstance in which construction workers were deemed to be exposed to formaldehyde was working with particle board or plywood, typically through carpentry work, building maintenance or sanding prior to painting. Working with particle board as a carpenter was assigned medium level exposure and working with particle board during maintenance or sanding as preparation for painting was assessed as low level exposure. Thirty-six workers (66%) reported using power tools (usually sanding or cutting) or hand tools while working with particle board or plywood in their role as carpenters or related construction workers. Twelve painters (18%) reported sanding particle board or plywood and seven said they usually used a powered sander (Table 8).

Table 8: Main circumstances resulting in probable exposure to formaldehyde

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Carpenter using power tools	-	36	-	36
Other construction working hand sanding	-	1	19	20
Painter	-	-	12	12

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

The use of controls

Of those construction workers who used power tools when working with particle board or plywood, 16 (29%) reported usually using a simple half face paper mask, 14 (25%) used ventilation (local exhaust ventilation or on tool extraction systems), five (9%) used both the paper mask and ventilation systems and 21 (38%) reported not using any form of control to prevent or reduce exposures in the workplace. Only two painters reported using RPE whilst using a power sander. One of the five painters who only sanded by hand reported using RPE. 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. Overall, 56% of construction workers exposed to formaldehyde reported using some form of control to prevent exposure to formaldehyde (Table 9). Regardless of whether controls were used or not, exposures were not adjusted for carpenters using power tools because the hygienists considered the controls used were not adequate to minimise exposures.

Overall, 56% of construction workers exposed to formaldehyde reported using some form of control to prevent exposure

Table 9: The reported use of controls when performing tasks with probable exposure to formaldehyde

Exposure circumstance	Yes-use of controls reported (n)	No-use of controls not reported (n)	Total (n)
Carpenters working with power tools	22	14	36
Other construction worker hand sanding	13	7	20
Painters working with (power) sanders	2	5	7
Painters only sanding by hand	1	4	5
Total	**38**	**30**	**68**

Note: Workers who reported always or usually using ventilation systems or wearing respiratory protection during relevant work activities were grouped as ‘yes’. Those workers who reported sometimes or never using ventilation systems or wearing respiratory protection during relevant work activities were grouped as ‘no’.

Ionizing radiation

Ten (2%) workers were deemed to have a probable exposure to ionizing radiation (none had possible exposure). Of those exposed, 20% were assigned a medium level exposure and 80% a low level exposure.

Eighty per cent of the workers were technicians and trades workers.

Circumstances of exposure

Nine of the 10 probably exposed workers were exposed to x-rays (electricians, welders inspecting welds and a construction worker). The remaining worker deemed to have a probable exposure to ionising radiation was a manager exposed to cosmic radiation at high altitude through frequent flying.

The use of controls

Information on the use of controls was not collected for tasks associated with probable exposure to ionising radiation.

Lead

One hundred and twelve (24%) workers were deemed to have a probable exposure to lead. Of those exposed, 38% were assigned a high level exposure, 40% a medium level exposure and 22% a low level exposure.

The workers were most commonly technicians and trades workers (71%) and labourers (16%).

Circumstances of exposure

The main tasks which led to a probable exposure to lead were soldering (48%), which was assigned either a high or medium level exposure; painting involving the removal or use of lead-based paints (24%), assigned a high or medium level exposure; general plumbing work (25%), assigned a low level exposure; and plumbers handling lead flashing (16%), assigned a low exposure (Table 10).

Table 10: Main circumstances resulting in probable exposure to lead

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Soldering	22	32	-	54
Painting	16	11	-	27
Plumbing (general)	-	-	28	28
Handling lead flashing	-	-	18	18

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

The use of controls

Use of controls was reported for both the soldering and machining tasks. For soldering, controls included the amount of time the respondent soldered outdoors, and the amount of time spent soldering where a ventilation system (welding booth, exhaust hood or local exhaust ventilation) was in place and the use of an air-supplied welding helmet. For soldering tasks, controls were considered adequate for exposure assessments to be adjusted if the respondent soldered more than half the time outdoors, soldered where a ventilation system was in place for more than half the time or wore an air-supplied welding helmet. Of the 54 workers exposed through soldering, only five (9%) reported wearing an air-supplied helmet. Almost two-thirds (63%) of painters reported using some form of control to prevent exposures when painting old houses, ships and bridges.

Nickel

Nineteen (4%) workers were deemed to have a probable exposure to nickel. Of those exposed, 63% were assigned a high level exposure, 26% a medium level exposure and 11% a low level exposure.

The workers were most commonly technicians and trades workers (79%) and labourers (16%).

Circumstances of exposure

Seventeen (89%) of the workers were probably exposed through welding and six (32%) through machining stainless steel. Four workers were exposed through both activities (Table 11).

Table 11: Main circumstances resulting in probable exposure to nickel

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Welding	12	4	1	17
Machining	-	-	6	6

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

The use of controls

Limited information was collected on the use of controls for tasks associated with probable exposure to nickel. Information was available for 12 workers who welded. Of these workers, one reported using a welding booth more than 50% of the time and the other 11 reported using a welding booth less than 50% of the time. Seven reported welding outdoors more than 50% of the time and the remaining five reported welding outside less than 50% of the time. Six reported sometimes welding in confined spaces and the other six reported that they did not weld in confined spaces. Information was available for one of the six workers who machined metal—this worker did not report working in ventilated areas (fan in window or doorway, open windows or doors, ventilated room) or using RPE.

Other Polycyclic Aromatic Hydrocarbons (PAHs)

Thirty-four (7%) workers were deemed to have a probable exposure to other PAHs apart from those included in DEE exposure assessments. Of those exposed, 27% were assigned a high level exposure, 32% a medium level exposure and 41% a low level exposure.

The workers were most commonly technicians and trades workers (47%), machinery operators and drivers (29%) and labourers (24%).

Circumstances of exposure

Construction workers were probably exposed to other PAHs through fumes from asphalt during road construction (35%)—hot asphalt processes were assigned a medium level exposure and cold asphalt processes were assigned a low level exposure); working with wood treated with preservative (low level exposure), applying the preservative (medium level exposure); mixing tar (high level exposure); welding coated surfaces (low level exposure); burning waste in the open (high level exposure); and burning off paint (medium level exposure) (Table 12).

Table 12: Main circumstances resulting in probable exposure to PAHs

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Road construction	-	7	5	12
Using treated wood	-	1	5	6
Mixing tar	5	-	-	5
Welding surfaces with a coating	-	-	3	3
Burning waste	3	-	-	3
Burning paint	-	2	-	2

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

The use of controls

Limited information was collected on the use of controls for tasks associated with probable exposure to other PAHs. Information was available for the three workers who welded coated surfaces, none of whom reported the use of any controls. Questions about controls designed to prevent dermal exposures were not asked for any of the tasks described above.

Solar ultraviolet (UV) radiation

Most workers (n=396, 86%) were deemed to have a probable exposure to solar UV radiation. Of those exposed, 64% were assigned a high level exposure, 29% a medium level exposure and 7% a low level exposure.

The workers were most commonly technicians and trades workers (61%), labourers (21%) and machine operators and drivers (10%).

Circumstances of exposure

Construction workers were deemed to have probable exposure to solar UV radiation through outdoor work, with the time spent working outside and the use of controls determining the level of exposure. Six per cent of the workers reported spending less than one hour each day working outside, 26% spent between one and four hours working outside and 68% spent more than four hours each day working outside (Table 13).

Table 13: Main circumstances resulting in probable exposure to solar UV radiation

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Outside greater than four hours	253	20	0	273
Outside between one and four hours	-	95	8	103
Outside less than one hour	-	-	20	25

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

The use of controls

Information was available on the use of four methods for preventing solar UV exposure—use of sunscreen, wearing a hat, wearing protective clothing that covers up arms and legs, and working in the shade. Controls were considered adequate if workers reported using all four methods for 50% or more of the time. Only eight per cent of the people who spent four or more hours a day outside were considered to be using adequate controls based on this definition but 33% used sunscreen, a hat and covered clothing 50% or more of the time. Wearing a hat (81%) and clothing (78 %) were the most common methods for preventing UV exposures used by workers when working outside (Table 14).

Wearing a hat (81%) and clothing (78 %) were the most common methods for preventing UV exposures used by workers when working outside

Table 14: Reported use of controls when working outdoors

Length of daily exposure	Sunscreen (n)	Hat (n)	Clothing (n)	Shade (n)	All controls (n)
Outside greater than four hours	125	227	210	62	20
Outside between one and four hours	39	76	75	36	8
Outside less than one hour	7	18	23	10	5
Total	171	321	308	108	33

Trichloroethylene

Nineteen (4%) workers were deemed to have a probable exposure to trichloroethylene. Of those exposed, 16% were assigned a high level exposure and 84% a medium level exposure.

The workers were most commonly technicians and trades workers (42%) and labourers (32%).

Circumstances of exposure

All probable exposure to trichloroethylene was a result of undertaking degreasing tasks, usually with room temperature solvent (assigned a medium level exposure) and with approximately half involving hand dipping and half involving spray degreasing. Degreasing tasks where heated solvent was used were assigned a high level exposure (Table 15).

Table 15: Main circumstances resulting in probable exposure to trichloroethylene

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Degreasing with heated solvent	2	-	-	2
Hand degreasing (room temperature)	-	8	-	8
Spray degreasing (room temperature)	-	8	-	8
Degreasing (room temperature)	-	3	-	3

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

The use of controls

Limited information was collected on the use of controls for degreasing tasks associated with probable exposure to trichloroethylene. Information was available for one worker who reported degreasing at room temperature using a tank equipped with a ventilation system. Questions about controls designed to prevent dermal exposures were not asked.

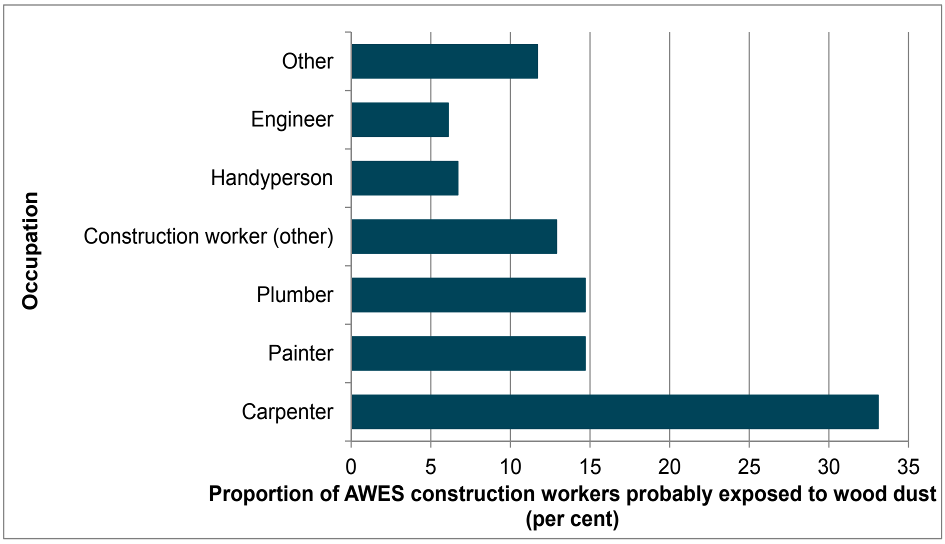
Wood dust

One hundred and sixty-three (36%) workers were deemed to have a probable exposure to wood dust.

One hundred and sixty-three (36%) workers were deemed to have a probable exposure to wood dust. IARC did not differentiate between types of wood when classifying "wood dust" as carcinogenic so all types of wood dust were included in the AWES. Of those exposed, 47% were assigned a high level exposure, 23% a medium level exposure and 29% a low level exposure.

The workers were most commonly technicians and trades workers (65%) and labourers (26%), with carpenter the most common specific occupation (Figure 4).

Figure 4: Occupation of AWES construction workers with probable exposure to wood dust



Circumstances of exposure

Construction workers were deemed to have probable exposure to wood dust through several different tasks. Carpentry work (36%) resulted in probable exposure when sanding by hand (medium level exposure) or with a power sander (high level exposure), rough and finishing carpentry using hand tools or powered tools (low level exposure), laying wooden floors (medium level exposure) and demolition work (low level exposure) (Table 16).

Painting preparation was another commonly reported task resulting in probable wood dust exposure. This consisted of sanding of chipboard (21%; high or medium level exposure depending on the use of control measures) and sanding of wood (37%; medium or low level exposure depending on the use of control measures). Another 12% of workers were exposed when machining or making wooden parts.

Table 16: Main circumstances resulting in probable exposure to wood dust

Exposure circumstance	High (n)	Medium (n)	Low (n)	Total (n)
Rough and finishing carpentry	-	-	46	46
Laying wooden floors	-	37	-	37
Demolition	-	-	34	34
Sanding by carpenters—hand tools	-	19	-	19
Sanding by carpenters—power tools	36	-	-	36
Sanding by painters—hand tools	9	14	2	25
Sanding by painters—power tools	10	7	-	17
Machining of wood	19	-	-	19

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

The use of controls

Of those performing carpentry, information on the use of controls was available for most (87%) workers. The use of mechanical ventilation was only reported by 21% of workers (Table 17). About half (54%) reported using a paper dust mask and about half (46%) reported not using any RPE. Information on the use of control measures by painters was limited but the reported use ranged from about 33–50% for RPE depending on the task. Information on control measures used by machinists was not available.

Table 17: The reported use of controls when performing tasks with probable exposure to wood dust

Exposure circumstance	Half-face paper mask (n)	Ventilation (n)	Both (n)	None (n)	Total (n)
Carpenters using power tools	20	6	5	22	53

Note: This table doesn't include all exposed workers and workers may have used more than one control.

DISCUSSION AND INTERPRETATION OF THE STUDY FINDINGS

Exposures and controls

The most common exposures were to solar UV radiation, ETS, DEE, crystalline silica and wood dust.

In the AWES 96% of the respondents who were categorised as working in construction industry were probably exposed to at least one carcinogen included in the study and about half were probably exposed to four or more. The most common exposures were to solar UV radiation, ETS, DEE, crystalline silica and wood dust.

CAREX Canada identified the most common exposures in the construction industry in Canada as solar UV radiation, crystalline silica, wood dust, asbestos and DEE (CAREX Canada 2012; Peters et al. 2015). All of these except asbestos were in the top five most common exposures found in the current study. As mentioned earlier, asbestos (Consonni et al. 2015), crystalline silica (Consonni et al. 2015), solar UV radiation (Boniol et al. 2015) and DEE (Rushton et al. 2010) have all been identified as common exposures in the construction industry in other countries. The construction industry was identified in the NHEWS study as having the highest prevalence of exposure to wood and related dust (30%), acids and alkalis (35%) and dusts from processed materials (17%) and to have high prevalence of exposure to direct sunlight (60%); "dust" (concrete and cement, wood dust, "environmental dust" and "road dust") (65%); and gases, vapours, smoke or fumes (23%). However, the NHEWS study did not identify specific carcinogenic hazards and was based on self-reported exposure, which means it is not possible to directly compare the results from the two studies (MacFarlane et al. 2012; Safe Work Australia 2009).

CAREX EU found a much lower prevalence of carcinogen exposure for all carcinogens in the construction industry compared to the findings in this study (Kauppinen et al. 2000). This was also the case for the UK Burden of Disease study (Brown et al. 2012; Cherrie et al. 2007; Rushton et al. 2010; Rushton et al. 2012). Some of the differences in the prevalence estimates between the studies probably reflect the different industry proportions in the countries in which the studies were based. The studies also used quite different methods—AWES was the only study that surveyed workers about what tasks they actually performed at work and it took into account the use or non-use of control measures. CAREX EU estimates were based on workplace measures taken for a range of reasons and expert opinion. The UK Burden study used a similar approach, although probably with better local exposure information. The definition of exposure in the studies also appears to have been different, although it is difficult to make a direct comparison. The higher exposure prevalence in the AWES project suggests it accepted lower exposures, or a lower probability of exposure in exposed subjects than did the other two studies. 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 workplace exposure estimates as part of their methodology.

Arsenic

Six per cent of construction workers in the AWES were deemed to have a probable exposure to arsenic when working with CCA-treated wood. There was no information on the use of control measures, but measures should focus on the suppression of wood dust and wearing gloves when handling treated timber, particularly if it may not be fully dry. Information on safe working practices is available from Safe Work Australia and WorkSafe Western Australia guidance notes (Commission 1989; WorkSafe Western Australia 2001).

Asbestos

The AWES method estimated that a large number of exposures to asbestos were possible (that is there was a chance a person could be exposed but there was not enough information available to determine whether they were exposed or not).

Four per cent of construction workers in the AWES were deemed to have probable exposures to asbestos, mainly through servicing brakes and through loading, unloading or transporting asbestos-containing waste. This is slightly lower than that reported for construction workers in CAREX Canada (5.2%) and considerably lower than study of plumbers in the United Kingdom (Burdett & Bard 2007). The AWES method estimated that a large number of exposures to asbestos were possible (that is there was a chance a person could be exposed but there was not enough information available to determine whether they were exposed or not) rather than probable (that is it is likely this person was exposed to asbestos). Workers were asked if they cut millboard, lagging or fibro but these terms are in common usage—they refer to materials that historically contained asbestos but whose modern day equivalents do not. In addition, other work has shown a general lack of understanding among trades workers as to which products contain asbestos and in practice their ability to identify asbestos-containing materials was limited. This was the basis for assigning possible exposure to asbestos rather than probable exposure. None of the AWES respondents were classified as demolition workers so information about demolition tasks was not collected. The Model WHS Regulations have provisions covering demolition and removal of asbestos-containing material (Safe Work Australia 2014). Two relevant Safe Work Australia codes of practice address the proper approach to asbestos control and removal (Safe Work Australia 2011a; 2011b). Exposure through brake servicing will be expected to diminish over time as industrial vehicles with asbestos in the brake linings are phased out.

Benzene

Fourteen per cent of construction workers in the AWES were deemed to have probable exposures to benzene, primarily from refuelling petrol-powered vehicles or equipment and also through degreasing with petrol. Safe Work Australia's guidance material on the health monitoring of benzene considers petrol evaporation as a non-work exposure circumstance (Safe Work Australia 2013b) and there is currently limited information provided by Safe Work Australia about potential controls to eliminate or reduce benzene exposure. Work Safe Alberta in Canada released a workplace Health and Safety Bulletin on Benzene at the Work Site and makes recommendations on the use of controls, focusing on the standard hierarchy of controls (Work Safe Alberta 2010).

Chromium VI

Eighteen per cent of construction workers in the AWES were deemed to have probable exposure to chromium VI, with the main exposures arising from working with CCA-treated wood, welding, burning zinc chromate paint off surfaces and concreting. Significant exposure to chromium VI in the construction industry has been documented elsewhere (NIOSH 2013). Of those workers exposed through welding, some controls were used about half the time. Local exhaust ventilation has been shown to be effective in controlling welding fumes (Flynn MR & P 2012). The Safe Work Australia code of practice on welding also provides guidance on appropriate control measures (Safe Work Australia 2012a).

Crystalline silica

About one third (38%) of construction workers in the AWES were deemed to have a probable exposure to crystalline silica. These exposures mainly occurred when the worker was working with concrete or cement, or was involved in building construction or renovation. Silica is well known to be a common exposure in the construction industry, particularly where excavation into sandstone is required (such as in places on the Eastern seaboard of Australia, and in particular in the Sydney basin) (CAREX Canada 2012; Cherrie et al. 2007; Consonni et al. 2015; Peters et al. 2015).

Silica is well known to be a common exposure in the construction industry

Guidance is available on how to eliminate or minimise exposure, with the use of sprays to dampen dust and using appropriate ventilation two of the key control measures (Flynn & Susi 2003; OSHA 2015; Safe Work Australia 2012b; 2013a; 2015; Workplace Health and Safety Queensland 2013).

Diesel engine exhaust (DEE)

About one-third (37%) of construction workers in the AWES were deemed to have a probable exposure to DEE. The exposure occurred when persons were working in or around diesel-powered vehicles or equipment. Exposure assessment was based on the proximity of diesel powered vehicles, the ventilation (including working outside) and whether or not the worker smelt DEE. DEE can be smelt at levels of about 5 ppm (Fiedler et al. 2004). Such exposure is of particular concern given IARC's recent designation of DEE as a definite human carcinogen based on increased risks of lung cancer (IARC 2012). DEE has previously been identified as a common exposure in many Australian industry sectors (Peters et al. 2015) and in the construction industry in different parts of the world (CAREX Canada 2012; Peters et al. 2015; Rushton et al. 2010).

Guidance material is provided by Safe Work Australia on the health monitoring of persons exposed to PAHs, including DEE and more recently, specific guidance on DEE has been developed to provide information about potential controls to eliminate or reduce DEE exposure. A WorkCover NSW fact sheet titled 'Staying safe around diesel exhaust emissions' recommends approaches such as substituting vehicles with ones that have safer engines, using particle filters, scheduling regular maintenance of the equipment and minimizing the amount of time spent around the emissions (WorkCover NSW 2015).

The Occupational Safety and Health Administration (OSHA) released an information sheet that outlines potential engineering controls that can reduce exposure to DEE, with examples including performing routine maintenance on diesel engines, installing engine exhaust filters and using cleaner burning engines. They also suggest administrative controls such as restricting the amount of diesel powered equipment in an area, maximising distance between the worker and the relevant machine and prohibiting or restricting unnecessary machine idling (OSHA 2013). While some guidance recommends the use of cleaner fuels, changes made to the Australian diesel fuel quality standard in 2009 mean diesel is supplied as ultra-low sulphur diesel (ULSD) fuel.

Environmental tobacco smoke

Fifty-nine per cent of the construction workers in the AWES were deemed to have a probable exposure to ETS. This occurred when fellow workers smoked in the vicinity of the worker. About one quarter of these exposed workers were exposed indoors and in almost half of these instances there were bans in place intended to stop smoking indoors. Similarly, exposure at entrances to workplaces and in outdoor areas still occurred despite smoking bans being in place in many workplaces. The National Occupational Health and Safety Commission (NOHSC) guidance note supporting the elimination of ETS (‘Guidance note on the elimination of environmental tobacco smoke in the workplace’) in the workplace recommends that smoking be prohibited in all workplaces (NOHSC 2003). Most jurisdictions have legislation banning some or all smoking at workplaces, and many individual workplaces comply with or impose their own such bans. However, the results from this study suggest that there is need for widespread adoption (enactment of relevant anti-smoking legislation in those jurisdictions yet to do so) and enforcement of workplace smoking bans.

Formaldehyde

All exposures were to dusts from particle board or plywood generated by the use of power tools or sanding.

Fifteen per cent of construction workers in the AWES were deemed to have a probable exposure to formaldehyde. All exposures were to dusts from particle board or plywood generated by the use of power tools or sanding. Exposure to formaldehyde in some Australian workplaces has been previously documented by NICNAS (NICNAS 2006; 2013) and the Australian Safety and Compensation Council (ASCC) (ASCC 2008). Significant exposures to formaldehyde have also been documented in the Canadian construction industry (CAREX Canada 2012; Peters et al. 2015). Recommended control measures are similar to those for most types of wood dust—use of local exhaust ventilation, area ventilation, appropriate RPE and vacuuming wood dusts (ASCC 2008; Goyer et al. 2006; HSE 2012; 2014). In this study, 56% of construction workers exposed to formaldehyde used some form of controls to prevent exposures but in some cases it is likely to not have been adequate—for example, workers using simple paper masks. The formaldehyde exposure levels emanating from particle boards and plywood appear to have significantly decreased in the last decade or so. Although it has been argued that such exposure now only occurs during manufacture if products meeting Australian low-emissions standards are used for construction work (EWPAA 2012), the AWES method assumes formaldehyde exposures can occur when working with particle board and plywood.

Ionizing radiation

Only 2% of workers in the AWES were deemed to have a probable exposure to ionizing radiation, almost all of which was to x-rays from technical equipment. Such exposures are governed by national standards (ARPANSA 2002b) and guidance (ARPANSA 2002a).

Lead

About one quarter (24%) of the construction workers in the AWES were deemed to have a probable exposure to lead, mainly through soldering, painting with or removing lead paint, general plumbing work or working with lead flashing. The reported use of controls when soldering, such as using ventilation systems or wearing RPE, was not often considered adequate, which is of particular concern because inhalation of lead fume can be a significant source of lead exposure (National Toxicology Program 2011). Guidance on safe work practice when there is potential lead exposure is widely available (NOHSC 1994; Safe Work Australia 2012c; WorkCover Queensland 2015; Worksafe Victoria 2000).

Nickel

Four per cent of construction workers in the AWES were deemed to have a probable exposure to nickel through welding or machining stainless steel. The reported use of controls was considered adequate about half the time for those who welded. The Safe Work Australia code of practice on welding provides information on relevant exposure control measures (Safe Work Australia 2012a).

Polycyclic aromatic hydrocarbons

Seven per cent of construction workers in the AWES were deemed to have probable exposures to PAHs, mainly from asphalt fumes during road construction. These exposures have been documented elsewhere (McClean et al. 2004; NIOSH 2001; Sobus et al. 2009a; Sobus et al. 2009b) and relevant exposure control measures include processes that minimise fume production, local fume extraction where possible, having enclosed cabins on vehicles, minimising the time spent by workers close to the source of fumes, and the use of RPE where necessary (NIOSH 2001).

Solar UV radiation

The vast majority (86%) of construction workers in the AWES were deemed to have a probable exposure to solar UV radiation when working outdoors.

The vast majority (86%) of construction workers in the AWES were deemed to have a probable exposure to solar UV radiation when working outdoors. This high prevalence of exposure to solar UV radiation has previously been documented in the construction industry elsewhere (CAREX Canada 2012; Peters et al. 2015) and in Australia workers in many industrial sectors (Carey et al. 2014a).

Safe Work Australia has released a set of guidelines for the management of solar UV exposure. Potential control measures identified in the guidelines are working in shaded areas, eliminating or reducing reflective nature of surfaces, window tinting or glass, changing work schedules to limit time spent outdoors when UV is highest and the use of personal protective clothing and sunscreen. Combining control measures is the most effective way of reducing exposure (Safe Work Australia 2013c). The use of adequate protection by workers was poor (seven per cent of exposed workers in this study, based on using all methods), but a quarter of workers used sunscreen, a hat and covered clothing 50% or more of the time and three quarters used a hat or sunscreen some of the time.

Trichloroethylene

The NICNAS trichloroethylene safety factsheet provides recommendations on the safe use of the solvent (NICNAS 2013).

Four per cent of workers in the AWES were deemed to have a probable exposure to trichloroethylene through degreasing tasks. The NICNAS trichloroethylene safety factsheet provides recommendations on the safe use of the solvent (NICNAS 2013). It recommends that where possible a safer product or process should be substituted, that it should be phased out for cold cleaning and that it should not be used as a spray or aerosol. It also suggests using exhaust ventilation when trichloroethylene is being mixed or used and to avoid skin contact by wearing long sleeved shirts, trousers and viton gloves. Of those AWES construction workers who were deemed to have a probable exposure to trichloroethylene when degreasing, 42% reported spraying parts—that is the NICNAS recommendation was not followed. Limited information was collected on the use of ventilation or PPE. Other guidance materials also provide suggestions for reducing exposures to trichloroethylene (HSE 2015; NOHSC 1989).

Wood dust

About one third (36%) of AWES construction workers were exposed to wood dust. Significant exposure to wood dust has also been identified in the construction industry elsewhere (CAREX Canada 2012; Cherrie et al. 2007; Peters et al. 2015). Exposure occurred through sanding, rough and finishing carpentry, and demolition. The use of dust control measures such as mechanical ventilation and RPE considered appropriate for wood dust exposures was not commonly reported. There are many guides available outlining approaches to prevent or minimise exposure, with the main approaches including use of local exhaust ventilation, area ventilation, appropriate RPE and vacuuming to clean up wood dusts (ASCC 2008; HSE 2012; 2014). IARC did not differentiate between types of wood when classifying "wood dust" as carcinogenic so all types of wood dust were included in the AWES.

Gaps, strength and weaknesses

Data for this report were taken primarily from the AWES project as limited other relevant data sources that include information on work tasks and exposures exist. The AWES project provides population-based information on current Australian workplace exposure to a range of definite and probable carcinogens while completing relatively common workplace tasks or in certain workplace circumstances. This information can be used to distinguish areas that require work in order to decrease the exposures that are common in the construction industry. The data should be representative of exposures and exposure circumstances in the construction industry in Australia. However, like any such survey, it has some limitations.

The AWES used a telephone survey to collect the data, which introduces problems with respondent's willingness to cooperate when interviews are too long. In order to minimize the time of the interview so that the required sample size could be reached, there had to be compromise between covering the essential questions and including questions that are important but not required for the primary purpose of the study. The AWES covered a

The AWES covered a range of potential exposures across a wide range of industry sub-sectors so a limited number of specific questions could be asked about any particular circumstance in a sub-sector.

range of potential exposures across a wide range of industry sub-sectors so a limited number of specific questions could be asked about any particular circumstance in a sub-sector. This is particularly relevant in the construction industry where there is such a large variety of sub-sectors. There were similar issues with the NHEWS project.

Error was probably introduced in the exposure assessment due to the reliance on self-report data. This is likely to be minimal as, unlike other studies that rely on the worker to recognize and recall specific exposures, the exposure assessment in the AWES asked questions on current job tasks undertaken and were guided by questions in the relevant job-specific modules. 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 within the construction industry. Information will be lacking on tasks that are specific to a particular occupation or industry sub-sector which is less common or which are undertaken by a relatively small number of people. If detailed information is required about a specific sector of the industry or a specific activity, this would require a targeted, specific research project to be undertaken.

Information on the use of control measures was collected in the AWES. However, due to the time constraints mentioned earlier, the questions asked regarding control use were primarily focused on those circumstances that would be most likely to affect the exposure assessment. As a result of this, questions regarding respiratory controls were the most commonly asked, as inhalation was the most common route of exposure. The time constraints also limited the collection of more specific and detailed information on control measures. As a result, potentially relevant information (such as specific type of ventilation) was not always collected.

A common issue in survey data collection is non-response resulting in potential selection bias. In the AWES, information is not available on those who did not participate, raising the possibility that those who participated had a different prevalence of exposure and different approach to the use of exposure control measures than those who did not participate. However, it is not possible to assess the extent of the potential selection bias.

The AWES was able to assess exposure to individual agents, rather than broad groupings such as those used by the NHEWS study. This allows better understanding of the hazard to which workers are exposed and potential risks, for example OccIDEAS classified exposures to “silica” rather than “construction dust” reported in NHEWS. The use of a population-based approach and subsequent ability to capture exposures across a wide range of construction workers are also particular strengths of this study. Further, the methodology used is useful in pinpointing areas where the control of exposure is not considered adequate.

Potential implications

This information can be used to distiguish areas that require work in order to decrease the exposures that are common in the construction industry.

Almost all AWES construction workers were estimated to be probably exposed to at least one carcinogen when performing relatively common activities at work. Tasks that are undertaken by workers in the construction industry are highly varied depending on the type of construction activity. There were nine carcinogens to which nine or more of the workers in the construction industry were probably exposed. While most of these workers will not develop cancer as a result of work-related exposures, they are at greater risk. Quantifying those risks is not straightforward and as a result, information is not readily available. Reviewing and assessing existing literature to derive such estimates was beyond the scope of this report.

The agents explored in the AWES are classified by the IARC as known or probable human carcinogens and, as for all hazardous workplace chemicals, risks to health and safety (or exposures) must be eliminated so far as reasonably practicable. However, this is not possible for some exposures. In these cases, the hierarchy of controls must be used to minimise risks so far as is reasonably practicable by substituting hazards (chemicals or work processes used) with something that poses less risk, isolating hazards from workers and others in the workplace or by using engineering controls. Where risks still remain, administrative policies must be implemented, so far as is reasonably practicable, before PPE is provided. In practice, a combination of controls might be used to minimise exposure because a single controls measure might not be sufficient.

Noting the AWES concentrated on common tasks rather than specific, high risk activities, the focus for additional preventative action should be based on a balance between the exposures with a high prevalence and the exposure circumstances for which there are proven control measures and that are most amenable to control. Based on the reported use of controls by AWES construction workers and recommendations in existing guidance, this suggests a focus on:

- using new generation diesel engines, regular maintenance of existing diesel-powered vehicles and equipment, installation and maintenance of filter systems (trap particulate matter), and work practices that minimise the time spent by workers in the vicinity of operating diesel engines
- widespread adoption (enactment of relevant anti-smoking legislation in those jurisdictions yet to do so) and enforcement of workplace smoking bans
- regular use of local exhaust ventilation (or carrying out activities in well-ventilated areas) and the use of RPE where workers are likely to be exposed to wood dust
- regular use of local exhaust ventilation (or carrying out activities in well-ventilated areas) and the use of RPE by workers when welding or soldering, and
- increased use of all sun protection measures—working in the shade, wearing protective clothing that covers up arms and legs, wearing a hat and using sunscreen.

Although there is some information available in the literature about the health effects, exposures and control of the carcinogens found in the construction industry, this information is not organized in a way which is convenient for the construction industry. There is a need for clear, concise and consistent information on the circumstances and control of exposures that is specifically tailored to the construction industry and possibly additional information for specific high risk construction sub-sectors.

Further research

Measuring exposures to specific carcinogen exposures in the workplace for some of the tasks identified in this report may be of potential use in validating the data collected in AWES.

The AWES provides information on current exposures within the construction industry. Measuring exposures to specific carcinogen exposures in the workplace for some of the tasks identified in this report may be of potential use in validating the data collected in AWES. There was no scope to complete this task as part of the AWES.

The work presented in this report could also be complemented by the collection of more widespread and detailed information on the use of control measures where probable carcinogenic exposures have been highlighted in this report. Further research could also help understand why appropriate control measures are not being used.

The potential burden of these exposures in terms of future cancer risk in construction workers can be estimated. A method to predict future risk of cancer based on exposures now has recently been developed based on the lifetime risk model (Rushton et al. 2012). With this model, current workers are divided into those exposed and unexposed to the carcinogen in a baseline year. The numbers of cancers in the future due to exposure are then calculated. Scenarios can then be applied to the current exposures, such as increased use of ventilation systems, etc. The change in number of cancers can be determined to see which actions would have the most effect.

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GLOSSARY

ABS	Australian Bureau of Statistics
ANZSCO	Australian and New Zealand Standard Classification of Occupations
ANZSIC	Australian and New Zealand Standard Industrial Classification
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AWES	Australian Work Exposures Study
DEE	Diesel Engine Exhaust
ETS	Environmental tobacco smoke
EWPAA	Engineered Wood Products Association of Australasia
HSE	Health and Safety Executive
IARC	International Agency for Research on Cancer
IRSST	Institut de recherche Robert-Sauvé en santé et en sécurité du travail
JEM	Job Exposure Matrix
JSM	Job Specific Module
LEV	Local Exhaust Ventilation
MIG	Metal Inert Gas (welding)
NHEWS	National Hazard Exposure Worker Surveillance (study)
NICNAS	National Industrial Chemical Notification and Assessments Scheme
NTP	National Toxicity Program
OccIDEAS	An online tool to manage interviews and assess exposures
OHS	Occupational Health and Safety
OSHA	Occupational Safety and Health Administration
PAHs	Polycyclic Aromatic Hydrocarbons
PPE	Personal Protective Equipment
RPE	Respiratory Protective Equipment
TIG	Tungsten Inert Gas (welding)
UV	Ultraviolet

APPENDIX 1

Table A1: Comparison of demographic characteristics between AWES construction workers probably exposed to carcinogens and all Australian construction workers

Demographic Characteristic	Study population n (%)	Australian Population[a] n (%)	Chi² p-value[b]
Gender			**0**
Male	452 (98.5)	695 086 (86.7%)	
Female	7 (1.5)	107 061 (13.3%)	
Age Group			**0**
18-34	90 (19.6)	325 257 (40.5%)	
35-54	256 (55.8)	369 906 (46.1%)	
55-65	112 (24.4)	106 984 (13.3%)	
State of Residence			**0.433**
New South Wales	145 (31.6)	222 516 (27.7%)	
Victoria	109 (23.7)	204 326 (25.5%)	
Queensland	78 (17.0)	177 957 (22.2%)	
South Australia	21 (4.6)	53 850 (6.7%)	
Western Australia	94 (20.5)	108 122 (13.5%)	
Tasmania	6 (1.3)	15 944 (2.0%)	
Australian Capital Territory	4 (0.9)	11 558 (1.4%)	
Northern Territory	2 (0.4)	7 802 (1.0%)	
Country of Birth			**0.258**
Australia	368 (80.2)	606 967 (75.7%)	
Other	91 (19.8)	195 180 (24.3%)	
Language Spoken at Home			0
English	452 (98.5)	692 678 (86.4%)	
Other	7 (1.5)	109 469 (13.6%)	
Highest education level			**0.633**
High school or less	168 (36.6)	307 383 (38.3%)	
Trade certificate or diploma	241 (52.5)	431 117 (53.7%)	
Bachelor degree or higher	50 (10.9)	63 647 (7.9%)	
Socioeconomic status[c]			
Fifth quintile (Highest)	107 (23.3)	205 591 (25.9%)	
Fourth	131 (28.5)	201 092 (25.3%)	
Third	94 (20.5)	170 945 (21.5%)	
Second	80 (17.4)	126 471 (15.9%)	
First quintile (Lowest)	47 (10.2)	89 910 (11.3%)	
Remoteness[d]			**0.294**
Major city	280 (61.0)	560 125 (61.0%)	
Inner regional	124 (27.0)	156 116 (27.0%)	
Outer regional	46 (10.0)	66 814 (10.0%)	
Remote/very remote	9 (2.0)	17 372 (2.0%)	

a. Using the ABS 2011 Census data for ANZSIC code E

b. p-value for difference between the study and Australian population for each demographic characteristic

c. From Socio-Economic Index for Areas Index of Relative Socio-economic Disadvantage (SEIFA IRSD)

d. From Australian Standard Geographical Classification Accessibility/Remoteness Index of Australia (ARIA+)