Hazard Surveillance for the Primary Prevention of Occupational Asthma:

A National Demonstration Project

Commissioned Research Report for SafeWork SA

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Executive Summary

This project sought to:

1. Examine compensable occupational asthma cases in South Australia over a three-year period, and identify associated work processes and substances.
2. Compare these processes and substances with corresponding information in the SABRE (Australia) and THOR/SWORD (UK) disease surveillance schemes.
3. Review hazard control and exposure assessment for occupational asthma-related processes and substances
4. Develop a sampling frame for workplaces where asthma cases have occurred or are likely to occur.
5. Conduct workplace inspections, and generate exposure and control data for hazard surveillance, using a stratified sampling approach in South Australia, but relevant on a national basis.
6. Compile best practice guidance material, and make it available to relevant workplaces and industry associations.

The work was conducted in three phases:

- Statistical review
- Workplace observations and information provision to participating companies
- Needs analysis and development of national advice

Statistical Review

A review of the SA WorkCover compensation data from 2000 to 2009 indicated that the number of asthma related claims was declining: 48 claims in 1999/2000 to 19 claims in 2008/2009.
To obtain information about characteristics of asthma-related claims, data from the 2007-2009 were reviewed in more detail. During this period, there was a total of 69 claims records that included the word 'asthma' (in any field). The 'Nature of Injury Description' was 'Asthma' for 68 of the records.
It is likely that the compensation claims only represent a small proportion of occupational or work-aggravated asthma. Asthma is a chronic condition that is usually managed through the treatment of symptoms or by avoiding triggers; absence from work and compensable medical costs are unlikely to be features of the majority of cases. In addition, a large range of environmental, genetic and socioeconomic risk factors have been identified, making it difficult to attribute workplace exposure as a cause or aggravator.
With only a small number of asthma-related claims, and a large number of industries and agents represented, it is concluded that compensation claims data alone are not sufficient for the identification of high-risk industries. However, it is interesting to note that primary education was the industry with the highest number of asthma-related claims. This supports the findings of a New Zealand study in which primary school and early childhood teachers were identified as a high-risk group. It is suggested that a possible explanation is the self-selection of subjects into occupations perceived as low-risk. Alternatively, exposure to asthma risk factors such as viral infections or indoor allergies may play a role.
There is mounting evidence that primary school and early childhood teachers are exposed to multiple viruses and that this insult to the immune system is manifested in higher disease rates, including reproductive issues.

A more proximal indicator of risk factors for workplace-induced asthma is available from disease surveillance schemes. The occupational respiratory disease programs SWORD/THOR (UK) and SABRE (Vic & Tas) identified the most common sensitizing agents as being isocyanates, latex, flour and grain, enzymes, laboratory animals and insects, cobalt and wood dust. These exposures arise in crash repair, woodworking, electronics assembly industries etc.

Workplace Observations

The project Steering Committee decided that a pilot survey of South Australian workplaces, where asthmagens identified from occupational respiratory disease surveillance schemes are used, would be carried out. The focus would be on the level of control to these agents, and other relevant information. International best practice hazard control information was compiled in preparation for the workplace visits.

In total, 70 workplaces were contacted and 30 workplaces agreed to participate in the survey, Twenty five were visited.
Experienced occupational hygienists visited these workplaces using a customised questionnaire/checklist. Between 2 to 4 hours was spent on site.
The workplaces visited were; woodworking, automotive, baking/flour, electronics and scientific /pathology industries. On the spot advice was provided during the visit, followed up with information, supplied on DVDs.

The results of the surveys indicated that most workplaces had some form of engineering control; however not all the engineering controls were effective at controlling exposure to the relevant asthmagens. Administrative controls including standard operating procedures, knowledge of the health hazards, chemical risk assessments and training appeared to range from non-existent to well-implemented. In many workplaces, respirators were available but were not used. In the automotive industry, airline respirators were worn while spraying isocyanate-based paints, but the compressed breathing air was not tested for quality.

Poor work practices such as use of compressed air to clean equipment to remove dusts and dry sweeping of dust were frequently observed during site visits.

The data from the workplace visits were utilized as part of a needs analysis.

Needs Analysis and National Advice

Although this was a pilot study, the consensus view of an expert panel of practising hygienists is summarized in the Table below. Deficiencies were evident with respect to administrative controls and personal protection in woodworking and flour handling processes.

Table: Hazard control needs analysis by asthmagen category

Control	**Woodwork**	**Isocyanates**	**Flour dust**	**Soldering fume**	**Pathology/ Formaldehyde**
Engineering (eg LEV)	+-	+-	+-	+	+-
Administrative (eg training)	--	--	--	+ -	+
PPE respiratory protective equipment	--	+	--	+	+-

+ indicates adequate control measures at the workplaces
+- Controls were in use but some were not very effective.
-- indicates inadequate control measures and improvements required at workplaces

Recommendations:

1. **The Safe Work Australia website should provide best practice information on the prevention of occupational asthma**

The UK Health and Safety Executive has developed a range of high quality asthma prevention resources that can be "Australianised". This information, along with local information, should be compiled and made available on the Safe Work Australia website.

2. **WHS authorities should implement a targeted awareness campaign, in conjunction with industry, followed by a regulatory campaign.**

An awareness campaign, referencing the abovementioned resources, should be implemented, followed up by a regulatory campaign focussing on the provision of health information, and the selection and use of ventilation systems and respiratory protective equipment. The awareness campaign can be in the form of roadshows, with the engagement of industry associations.

3. **A system of hazard control intelligence should be established.**

A larger-scale purposive survey of small, medium and large companies should be undertaken, with a repeat survey within the life of the current Australian Work Health and Safety Strategy. Workplace inspectors should accompany experienced hygienists, to assure access to workplaces. This hazard control "intelligence", in conjunction with reviews of disease surveillance data, will enable better targeting of efforts for the prevention of occupational asthma, as well as other diseases of short to medium latency. It will also enable international benchmarking.

The UK has been a leader in asthma prevention efforts, and it appears from a recently published[1] paper that the interventions applied in the motor vehicle repair industry are having success in reducing isocyanate exposures in that industry.

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[1] Jones K., Cocker J., Piney M. Isocyanate exposure control in motor vehicle paint spraying: Evidence from biological monitoring. *Ann Occup Hyg.,* 57(2): 200 -209 (2013)

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The Steering Committee discussed the review of SA Workcover claims data regarding causal agents for the previous three years. One of the difficulties with the workers compensation data was distinguishing between work-aggravated asthma and work-induced asthma. It was agreed by the Steering Committee that selection of workplaces for surveillance does not necessarily need to rely on compensation and disease surveillance data. It is known that many industries use identified asthmagens and worker exposure is likely. Identification of high-risk industries could be based on the occupational literature and the asthmagens encountered by occupational hygienists in SA.

The authors wish to acknowledge the assistance of SafeWork SA and all of the organisations, managers and employees who participated in the project.

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INTRODUCTION

The reduction of occupational disease is a key objective of the Australian WHS Strategy. A primary preventive approach is preferred.
In this regard, it is expected that a greater understanding/uptake of effective control measures by industry will lead to reduced exposures to health hazards. In turn, reduced exposures should lead to reduced rates of occupational disease.

Health hazard surveillance, albeit in an *ad hoc* manner, was a feature of government occupational health units in the 1980s to early 1990s, but restructuring and loss of scientific expertise from the mid 1990s led to a rapid drop in activity. In the context of the declining health hazard surveillance activity by regulatory bodies and a concomitant shortage of exposure data for the purpose of targeted prevention, this hazard surveillance demonstration project is timely.

Occupational asthma is a disease of short to medium term latency and is likely to be preventable by effective control of asthmagens. Thus it represents a good candidate for hazard surveillance.

A variety of workplace exposures can cause new cases (work-induced asthma) or exacerbate the symptoms of pre-existing asthma (work-aggravated asthma). The disease is commonly divided into two types: allergic (or sensiter-induced) and non-allergic (or irritant-induced). Sensitiser-induced asthma accounts for the majority (approximately 65-80%) of asthma cases (Court, Cook, & Strachan, 2002; Faniran, Peat, & Woolcock, 1999; Miraglia Del Giudice et al., 2002; Plaschke et al., 1999). In this type of asthma, there is a delay between exposure to the sensitiser and the onset of symptoms, the length of which varies according to a range of personal and environmental factors (Youakim, 2001). The mechanism by which substances cause respiratory sensitisation is not well understood, and it is believed that either long-term-low-level exposures or accidental high exposures may precipitate the condition. Apart from the obvious inhalational route, there is growing evidence that respiratory sensitisation may sometimes occur by dermal exposure (Bello 2007). For irritant-induced occupational asthma, the onset of symptoms occurs within hours of exposure to very high concentrations of irritants (Vandenplas & Malo, 2003).

If the exposure continues, a worker with occupational asthma will generally be unable to work in his or her job, and the financial and human costs can be very high. For example, a significant proportion of those with isocyanate-induced asthma are likely to have persisting symptoms for at least several years after exposure is avoided. This is similar to the experience of workers exposed to Western Red Cedar wood dust (Chan-Yeung 1982)

In order to address occupational disease, there is a need to develop indicators and baselines.

Upstream indicators (exposures and controls) are rarely compiled in a systematic fashion. An important benefit of using upstream indicators is the potential for primary prevention of disease.

Downstream indicators include those from compensation-based data sets, routinely collected hospital data, GP surveys and the National Health Survey. There has been some Australian activity in respect of occupational disease surveillance (e.g. SABRE) but it is very much a fledgling activity in comparison with the situation in the UK, where the University of Manchester maintains a national disease network (THOR) on behalf of the Health and Safety Executive.
The UK disease surveillance data suggest an incidence of 1,000 new cases per year. Reviews of these data suggest that the true figure may be as high as 2,000 – 4,000 cases per year. As a proportion of all asthma cases, it has been estimated that work exposures account for 9 – 15%. The top 10 agents for occupational asthma (asthamgens) are given in the figure below. High on the list are isocyanates, flour and grain and wood dust. These have been noted to be important asthmagens in Australian studies.

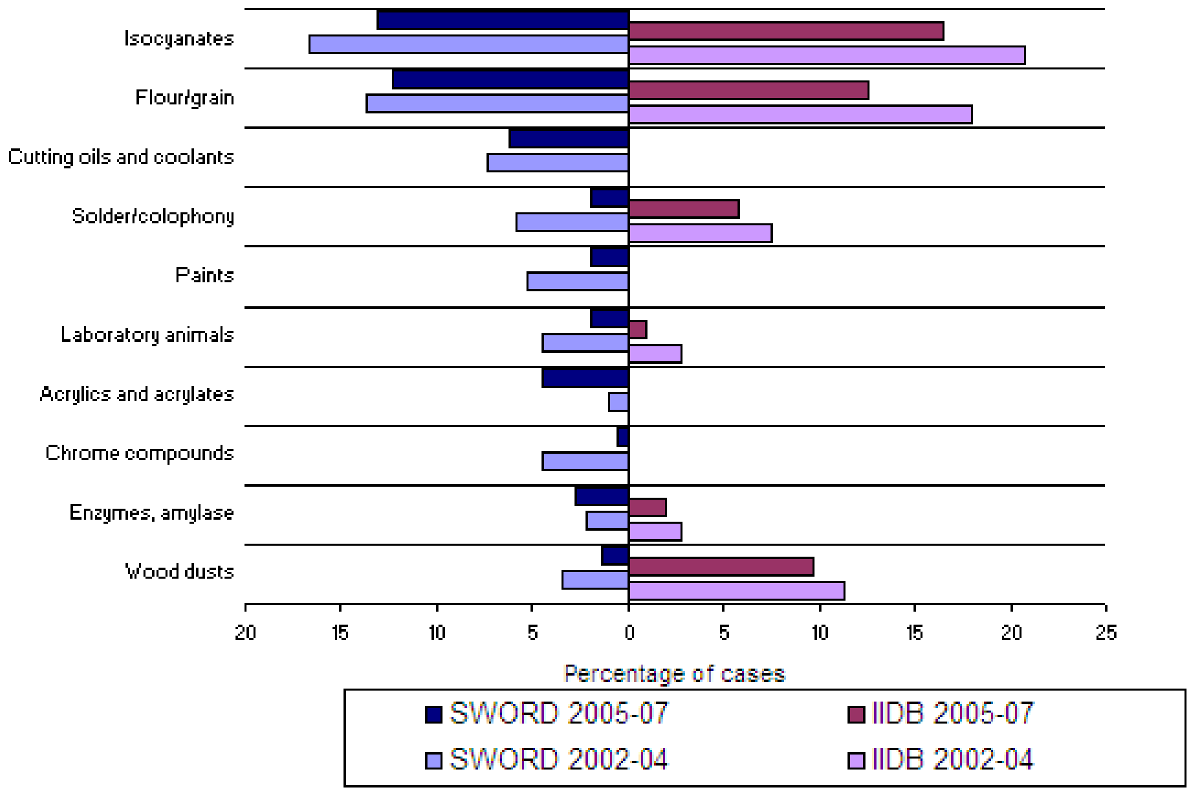

Figure 1: The top 10 agents for occupational asthma in the UK

This project sought to facilitate primary prevention of occupational asthma by demonstrating a hazard surveillance approach.
The steps involved were as follows:

- Examine compensable occupational asthma cases in South Australia over a three-year period, and identify associated work processes and substances.
- Compare these processes and substances with corresponding information in the SABRE (Australia) and THOR/SWORD (UK) disease surveillance schemes.
- Review hazard control and exposure assessment for occupational asthma-related processes and substances
- Develop a sampling frame for workplaces where asthma cases have occurred or are likely to occur.
- Conduct workplace inspections, and generate exposure and control data for hazard surveillance, using a stratified sampling approach in South Australia, but relevant on a national basis.
- Compile best practice guidance material, and make it available to relevant workplaces and industry associations.

PART 1 STATISTICAL REVIEW

1.1 Method

WorkCover SA compensation claims data from 1999 to 2010 was provided by SafeWork SA. The data were entered into Microsoft Excel® for analysis, including the calculation of time trends in the annual number of asthma-related claims for the preceding 10 year period and a more detailed review of data from the preceding 3 years to obtain information about the agency and mechanisms of injury and the industries associated with asthma-related claims. The preceding financial year is excluded because the claims record for that year is incomplete; receipt of claims relating to Self-Insured organisations is typically delayed for approximately 12 months from the date of the incident. The most recent financial year included in the analysis was 2008/2009.

1.2 Results

Figure 2 shows a steady decline in the annual number of asthma-related claims over the 10 year period, from 48 claims in 1999/2000 to 19 claims in 2008/2009.

To obtain information about characteristics of asthma-related claims, data from the preceding 3 years was reviewed in more detail. During this period, there was a total of 69 claims records that included the word 'asthma' (in any field). The 'Nature of Injury Description' was 'Asthma' for 68 of the records. For one of the records, the 'Nature of Injury Description' was 'Anxiety/Stress disorder' and the 'Worker Description of Accident' was 'asthma'.

Table 1 shows the agency of injury, agency of accident and mechanism of injury. It can be seen that fire, flame and smoke and dust were the agencies of injury accounting for the highest number of claims.

Table 2 shows the number of claims by industry. It can be seen that there were claimants from a broad range of industries. Primary education and hospitals were the industries that accounted for the highest numbers of claims.

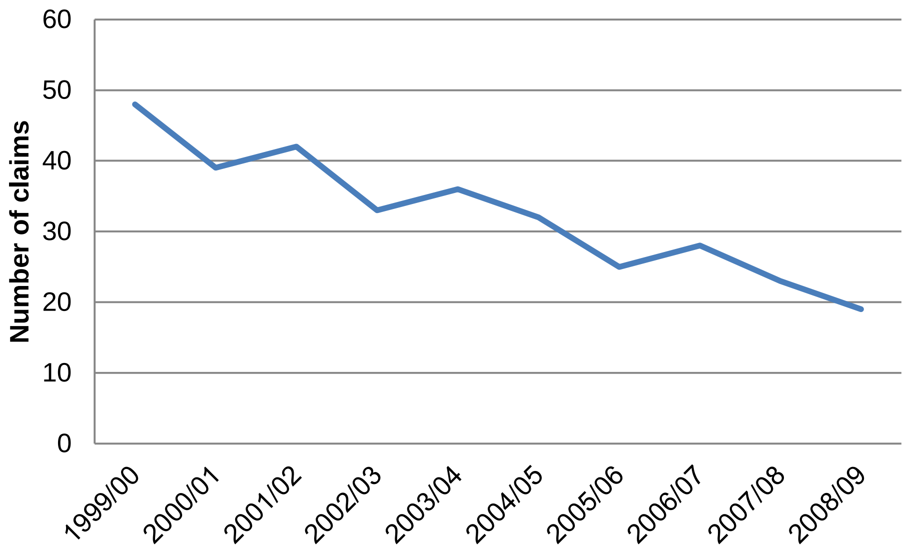

Figure 2: WorkCover SA asthma-related claims 1999/00 to 2008/09

Table 1: WorkCoverSA asthma-related claims 2006/07 to 2008/09 – Agency of injury, agency of accident and mechanism of injury

Agency of injury	Agency of accident (if specified)	Mechanism of injury
Fire, flame and smoke (9)	Cars (1) Control apparatus (1)	Single contact with chemical or substance (9)
Dust, not elsewhere classified (8)		Single contact with chemical or substance (7) Long term contact with chemicals or substances (1)
Other and not specified dust (7)	Abrasive, planing, cutting powered tools (1)	Single contact with chemical or substance (6) Long term contact with chemicals or substances (1)
Other dust (4)	Air conditioning (1)	Single contact with chemical or substance (4)
Other chemical products (3)		Single contact with chemical or substance (3)
Other industrial gases, fumes (3)	Pressurised containers (1) Switchboards and fuse boxes (1)	Single contact with chemical or substance (3)
Sand or soil (3)	Weather and water (1)	Single contact with chemical or substance (2) Long term contact with chemicals or substances (1)
Clothing and footwear (3)		Single contact with chemical or substance (2) Long term contact with chemicals or substances (1)
Fungicides (2)		Single contact with chemical or substance (1) Long term contact with chemicals or substances (1)
Non-physical agencies (2)		Work pressure (2)

Agency of injury	Agency of accident (if specified)	Mechanism of injury
Other and not specified chemical products (2)		Single contact with chemical or substance (1) Long term contact with chemicals or substances (1)
Other and not specified industrial gases, fumes (2)	Laboratory equipment (1) Trains (1)	Single contact with chemical or substance (2)
Paint, varnish (2)		Single contact with chemical or substance (2)
Sawdust (2)	Dressed timber (1) Other cutting, slicing, sawing machinery (1)	Single contact with chemical or substance (1) Long term contact with chemicals or substances (1)
Detergents (1)		Single contact with chemical or substance (1)
Internal conditions (1)	Trains (1)	Single contact with chemical or substance (1)
Non-bituminous hydrocarbon fuels (1)		Single contact with chemical or substance (1)
Other and not specified substances (1)		Single contact with chemical or substance (1)
Other basic and unspecified chemicals (1)		Single contact with chemical or substance (1)
Other nominated chemicals (1)	Other indoor environment (1)	Long term contact with chemicals or substances (1)
Other non-metallic minerals and substances (1)		Single contact with chemical or substance (1)
Other substances (1)		Single contact with chemical or substance (1)

Agency of injury	Agency of accident (if specified)	Mechanism of injury
Plant treatment chemicals (1)		Single contact with chemical or substance (1)
Stockfeed (1)		Single contact with chemical or substance (1)
Synthetic mineral fibres (1)		Single contact with chemical or substance (1)
Agency not apparent / Agency not known (5)		Single contact with chemical or substance (2) Long term contact with chemicals or substances (1) Other and multiple mechanisms of injury (1) Unspecified mechanisms of injury (1)

Table 2: WorkCover SA asthma-related claims 2006/07 to 2008/09 - Number of claims by industry

SAWIC Description	Number of claims
Primary education	7
Hospitals	6
Ambulance services	4
Employment services - category 1	4
Cafes and restaurants	3
Welfare and charitable services nec	3
Banks	2
Community health centres (medical)	2
Fabricated metal products nec	2
Non-residential building construction nec	2
Rail transport	2
Secondary education	2
State government administration	2
Technical services nec	2
Cleaning services	1
Clothing manufacturing	1
Commercial or job-printing and	1
Community health centres (paramedical)	1
Construction materials mining n.e.c	1
Department stores	1
Fire brigades and associated services	1
Grocers (including self service)	1
Metal coating and finishing	1
Motion picture exhibition	1
Non-building construction nec	1
Pathology services	1
Personal care services	1
Plant and flower retailing	1
Plastic products nec manufacturing	1
Police	1

SAWIC Description	Number of claims
Property operators and developers nec	1
Psychiatric hospitals	1
Residential care services nec	1
Road freight transport	1
Salt production by	1
Security and investigative services	1
Services to agriculture nec	1
Smash repairers	1
Wine	1
Wooden structural component manufacturing nec	1

1.3 Interpretation of workers compensation data

While the declining number of asthma-related claims is encouraging, it is likely that compensation claims represent only a small proportion of occupational or work-aggravated asthma cases. Asthma is a chronic condition that is usually managed through the treatment of symptoms or by avoiding triggers; absence from work and compensable medical costs are unlikely to be features of the majority of cases. In addition, a large range of environmental, genetic and socioeconomic risk factors have been identified, making it difficult to attribute workplace exposure as a cause or aggravator.
Lemiere et al (2012) looked at occupational risk factors associated with work-aggravated asthma in Quebec and found that there were significantly more exposures to ammonia, engine exhaust fumes, silica, mineral fibres, aerosol propellants and solvents. These findings appear to be similar to the SA workers compensation claims data. The majority of workers compensation data did not appear to be associated with agents that may *induce* occupational asthma such as isocyanates, wood dust, formaldehyde, rosin cored solder fume and flour and grain dust.

With only a small number of asthma-related claims, and a large number of industries and agents represented, it is concluded that compensation claims data alone is not sufficient for the identification of high-risk industries. However, it is interesting to note that primary education was the industry with the highest number of asthma-related claims. This supports the findings of a New Zealand study in which primary school and early childhood teachers were identified as a high-risk group (Eng *et al*, 2010). It is suggested that a possible explanation is the self-selection of subjects into occupations perceived as low-risk. Alternatively, exposure to asthma risk factors such as viral infections or indoor allergies may play a role.

1.4 Disease surveillance schemes

Occupational respiratory disease surveillance schemes have been established in Australia, the United Kingdom, Finland, the USA, Canada, France, Italy, Singapore and South Africa. However, many of the schemes are of limited scope or have been discontinued. Considered here will be the best-known program, the Surveillance of Work-related and Occupational Respiratory Disease (SWORD) project in the United Kingdom, together with the Australian scheme operating in Victoria and Tasmania, known as SABRE (Surveillance of Australian workplace-Based Respiratory Events). Both of these schemes are based on notifications from occupational and respiratory physicians. Although it has been acknowledged that these schemes underestimate the true incidence of the disease, they are likely to capture a higher proportion of cases than that reflected in compensation data.

SWORD

This program has operated since 1991 and covers the whole of the UK. In this scheme, respiratory physicians report as 'core' reporters (reporting every month) or 'sample' reporters (physicians sampled at random who report for one randomly allocated month each year). Only new cases seen within a reporting month are reported, and the decision as to whether the case is work-related is determined by the physician, although guidance for reporting is provided (Centre for Occupational and Environmental Health). In addition, SWORD receives details of respiratory illnesses reported by occupational physicians through the Occupational Physicians Reporting Activity (OPRA) (although these data are limited in coverage) (Meyer, Holt, Chen, Cherry, & McDonald, 2001). For the years 1992 to 1997, the scheme reported 38 cases of occupational asthma per million workers per year (McDonald, Keynes, & Meredith, 2000). In 1999, occupational asthma cases accounted for 26% of respiratory diseases, making it the second most frequently reported condition (Meyer, et al., 2001). The most commonly identified sensitising agents in 1999 were isocyanates (21% of reported cases), latex (9%), flour and grain (8%), enzymes (8%), laboratory animals and insects (7%) and cobalt (6%). In terms of occupation, for the years 1992 to 2001 the highest reported rates of asthma were in craft and related occupations, followed by plant and machine operators (McDonald, Chen, Zekveld, & Cherry, 2005).

SABRE

A surveillance scheme known as SABRE (Surveillance of Australian workplace- Based Respiratory Events), based on the UK SWORD model, has been operating in Victoria and Tasmania since 1997. In this scheme, respiratory and occupational physicians report new cases of occupational lung disease, together with causative details, smoking status and diagnostic confidence rating. Occupational asthma is the most common condition reported, with an incidence rate of 30.9 cases per million workers per year (Sim, 2005). In the first 3.5 years of the scheme, wood dust was the most common causative agent for asthma (Elder et al., 2004).

1.5 Comparison between data sources

Although the different data capture systems described do not allow for a meaningful comparison of incidence rates between populations, it is interesting to note that, as shown in Table 3, the rates of asthma incidence are very similar. Both surveillance systems and compensation records are likely to underestimate the true number of cases, seemingly to a similar extent. While the limitations of compensation data have been described, surveillance schemes have their own limitations. Surveillance schemes capture only the most serious cases, i.e. only those referred to specialists. In addition, due to the voluntary nature of the schemes, underreporting by eligible physicians has been acknowledged in both SWORD and SABRE.

Due to a smaller number of cases captured (reflecting a smaller population), the compensation data identified a variety of occupations and substances associated with asthma claims. Unlike the findings of the surveillance schemes, no particular high-risk substances or occupations were revealed.

Table 3: Occupational asthma rates (per million workers per year) from various data sources

Program / data source	Country / Location	Diagnosis	Years	Reporters	Participation rate among reporter group	Incidence rate
SABRE (Surveillance of Australian workplace Based Respiratory Events)	Victoria and Tasmania	Occupational asthma	1997-2001	Respiratory and occupational physicians	49% of eligible physicians	31
SWORD (Surveillance of Work-related and Occupational Respiratory Disease)	United Kingdom	Occupational asthma	1992-1997	Respiratory and occupational physicians	80-90% of respiratory and occupational physicians (eligibility unknown)	38
Workers' compensation claims records administered by WorkCover SA	South Australia	Work-related asthma coded by WorkCover or attributed by worker – medical diagnosis unknown	2006-2009	WorkCover SA	N/A	30

SA incidence rate: denominator = SA employed population from Year Book Australia (ABS), ave. 06/07 (756,000) and 08/09 (793,000) = 775,000

PART 2 WORKPLACE OBSERVATIONS

2.1 Fieldwork

2.1.1 Introduction

The project Steering Committee decided that a pilot survey of South Australian workplaces, where asthmagens identified from occupational respiratory disease surveillance schemes are used, would be carried out. The focus would be on the level of control to these agents, and other relevant information. International best practice hazard control information was compiled in preparation for the workplace visits.

A questionnaire/checklist was developed to be used during the site visits to allow consistent information to be obtained from all workplaces. The questionnaire covered the following areas;

- Asthmagen(s) used/handled/generated at the workplace
- Demographics
- Knowledge of health effects of the asthmagen
- Documentation of risk assessments for processes where exposure to the asthmagen was possible
- Training with respect to possible adverse health effects and controls including PPE usage & maintenance.
- The types of control measures used at the workplaces and an opinion on their effectiveness.

The results of the information obtained using this questionnaire/checklist and observations made during the site inspections are given in later sections of this report.

2.1.2 Description of Surveys

In total, 70 workplaces were contacted and 30 workplaces agreed to participate in the survey, Twenty five were visited.

Three occupational hygienists, Dr Joe Crea, Dr Michael Tkaczuk and Mr Ganyk Jankewicz who had between 22 to 34 years of occupational hygiene experience conducted the site visits and questionnaire surveys.

The time spent at the workplaces by the occupational hygienists ranged from 2 to 4 hours depending on the size of the workplace, the number of workers handling the asthmagen and the number of processes carried out at each workplace.

As the *Australian Work Health and Safety Strategy 2002 – 2012* had manufacturing as a priority industry in the list of broad industry groups and respiratory diseases this hazard surveillance focused on manufacturing industries where there was possible exposure to asthmagens during specific tasks which are given below.

The industries chosen were:

- Woodworking where either pine wood, chipboard or medium density fibreboard (MDF), made of pine, were in use as well as businesses where western red cedar was used in manufacturing wood items. The processes looked at were sawing, planing, shaping (e.g. using a spindle moulder) and sanding.
- Crash repairers using two pack isocyanate based paint where the processes involved

mixing the paint, spray painting in a spray booth, cleaning of the spray gun and sanding cured two pack isocyanate based paint.

- Electronics industries where rosin cored solders were used to connect wires or circuits, the processes could be automated or hand soldering.
- Industries using or producing flour such as grain mills and bakeries. The processes involved weighing out ingredients, sieving of flour and ingredients, mixing, spreading flour on trays and over products, emptying bags of flour.
- Pathology industries where formaldehyde was used to preserve tissue specimens and the tissues specimens were cut up for testing and later for disposal of samples after they were kept for a set period of time. An animal house where animals were kept for research was also visited to observe the workplace and work practices.

After contacting the workplace and the workplace having agreed to participate in the study/site visit, the occupational hygienist would arrange a date and time suitable for both the workplace and occupational hygienist for the site visit. The occupational hygienist would introduce themselves and explain that there was a questionnaire to gather information about the workplace and the activities and processes carried out where the asthmagen in question was used and where workers were potentially exposed to the asthmagen. The issue of what sensitization was, and what the result might be, was explained to the site contact - that is, for example, exposure to the asthmagen may cause an immune response. This process could occur after a short period of exposure or to up to 20 years of exposure depending on the individual susceptibility of the worker.

Any questions that were raised by the site contact were either answered immediately or the occupational hygienist stated that they would provide information. The questionnaire was administered first and then a walkthrough inspection carried out.

During the walkthrough inspection, the hygienist would provide recommendations on the spot. For example, in electronics assembly workplaces, if any issues were sighted such as exhaust ventilation being too far from the source of the solder fumes to be effectively captured, the occupational hygienist explained the limitations of exhaust ventilation systems and the need for LEV to be as close as possible to be effective.

At some locations where respirators were used the issue of facial fit was discussed with the site contact. Being clean shaven was important and it was explained that having any facial growth would affect the facial seal and reduce the protection provided by the respirators.

In woodworking workplaces there were a number of processes taking place and the effectiveness of local exhaust ventilation systems was visually checked. Some woodwork workplaces used collection bag filters which were located in the work area and it was explained that this type of LEV system can still generate fine wood dust while capturing the larger particulates generated. One of the issues sighted was that compressed air was still used at some workplaces to carry out cleaning processes on machinery and it was explained that this can generated a significant exposure for workers.

All vehicle repair workplaces visited used isocyanate two pack paints in spray booths and airline respirators when spray painting vehicles. The occupational hygienist pointed out that exposure to isocyanates could also occur during paint preparation, cleaning of the spray guns, dry sanding as well as the spray painting process.

Best practice control information was compiled by the occupational hygiene team and provided to all workplaces after all site visits were completed. This took the form of DVDs, with information relevant to the asthmagens that the workers at the workplaces were potentially exposed to. The DVDs were posted to the workplace contact with a covering letter.

2.1.3 General Observations

Woodworking

In wood working workplaces the main processes that can generate wood dust are sawing, planing, shaping (e.g. using a spindle moulder) and sanding. In general sawing generates larger sized wood particulates and sanding generates the finest sized particulates. The control of wood dust for most of these 4 processes had local exhaust ventilations (LEV) systems fitted. For bench and radial arm saws most of the workplaces observed had exhaust ventilation on the table but there was no auxiliary exhaust ducting to capture fine wood dust from the saw guard. Some workplaces had ducted systems where the cyclone or filters were located outside the building. All workplaces visited had some form of portable exhaust ventilation systems with filters/capture bags located near woodwork machines. The occupational hygienist pointed out that the filter/capture bags were not effective at capturing smaller sized wood particulates which would be released into the workplace. It was suggested that the filter/capture unit should be located outside the building. From observation the belt sanders exhaust ventilation was the least effective due to the distance between the point the wood dust was generated and the capture hood. The wood dust generated by hand sanding using portable electric or air powered sanders was generally poorly controlled and many workers were observed not to wear any respiratory protective devices. Cleaning at the workplaces was reported to be carried out by using compressed air to clean machinery and vacuum cleaners or brooms to clean the floors. It was reported that respirators were not worn at all times during the cleaning processes. The issue of maintenance of local exhaust ventilation systems was raised by the occupational hygienist and the response ranged from quarterly or six monthly maintenance of the systems and filters to breakdown maintenance.

Combined woodwork and isocyanate spraying

Only one workplace visited carrying out woodwork had its own spray booth where isocyanates were used to finish the wood products. At this location mixing of the two pack isocyanate was carried out in an area with no LEV system. The spray application of the isocyanate was carried out by one worker with a half face respirator in a spray booth, the occupational hygienist pointed out that spraying with isocyanates required the use of an airline respirator.

Crash repairers using isocyanates

The use of two pack isocyanate based paints involved four processes where potential exposure could occur. These were; mixing, spray painting, spray gun cleaning and sanding. Not every workplace visited had LEV in the mixing areas and respiratory protective equipment was not always used during this process. All workplaces visited appeared to have efficiently ventilated spray booths. Workers wore airline respirators while spray painting vehicles with two pack isocyanate based paints. Washing of spray guns was generally carried out at a gun washing station using recycled gun wash. In some workplaces there was no exhaust ventilation in the area where gun washing occurred. Some workplaces dry sanded the two pack isocyanate based paints and did not wear any respirator while carrying out this task. The occupational hygienist pointed out that active isocyanates could still be present in the dust generated by the dry sanding process and that either wet sanding or dry sanding while wearing a respirator would provide a control. The workplaces visited had indicating filters in the airline system to ensure clean breathable air for the spray painter. However, none of the workplaces reported that they had the compressed air used tested as per the South Australian OHS & W Regulations 2010 requirements.

Bakeries and flour mills generating flour dust

In bakeries and flour mills it was observed that some forms of engineering controls were in place to control flour dust during transfer of flour from hoppers to mixing containers. In some workplaces the loading from hoppers was automated and enclosed and at other workplaces operators manually controlled the transfer of flour from the hopper to the mixer. The occupational hygienist observed and indicated that some exposure the flour dust occurred during this process and some control measure should be considered.

In weighing rooms additives were weighed out and it appeared dusty to the occupational hygienist. Some local exhaust ventilation used in the weighing rooms did not appear to be effective. Flour was also dusted onto dough prior to going into the ovens. In some locations this was an automated process and at other workplaces this was carried out by hand and it appeared that some exposure to flour dust occurred during the manual dusting. Respiratory protection in the form of P2 dust respirators were available for use at some of the bakeries, however these were not always used. Generally, tasks that generated flour dust were those involving transferring, sieving, dusting and weighing of flour/ingredients. Cleaning of the work areas was usually by sweeping up spilled flour or ingredients and using compressed air to clean down equipment and machines. In some workplaces vacuum cleaning, brooms and compressed air were used to clean up flour in bakeries. It was observed by the occupational hygienist that respiratory protection did not appear to be worn in most workplaces during the above mentioned processes.

Electronics industries generating solder fume

In the workplaces where rosin cored solders were used, some of the soldering processes were automated. Robotics were used to carry out the bulk of the soldering work at one site. Where workers did carry out soldering, engineering controls in the form of either a local exhaust fan fitted with a filter or a local exhaust tube located near the tip of the soldering iron were in use. At some locations it was noted that the exhaust fans were located too far away from the soldering process to be effective at capturing the solder fumes. The occupational hygienist explained that the exhaust fans needed to be closer to the source of fumes to be effective. The production levels were reported to be normal on the days of the site visits.

Pathology facilities using formaldehyde

In the pathology facilities where exposure to formaldehyde was possible most workplaces had LEV system in place for workers to dissect the specimens. The LEV systems appeared to be effective in removing any vapour released during the dissection process. Storage of specimens was generally in a store room and a general exhaust ventilation was located in the room or in the storage area. The process of discarding tissue specimens in formaldehyde was not as well controlled, and release into the general atmosphere was likely.

Animal laboratory facility generating allergens

The controls in the area were laboratory animals were handled were mainly administrative controls and personal protective equipment. Workers were tested for allergies prior to commencing work and the work place was kept clean. The workers wore with gloves, goggles and gowns and hats when entering the work area.

2.2 Methods

Methodology

The substances which are classed as respiratory sensitizers were; formaldehyde, western red cedar dust, pine wood dust, isocyanates, animal dander/urine, rosin cored solder fume and flour (wheat) dust. Workplaces in South Australia were identified where exposure to these substances occurred, these were:

- Formaldehyde – Pathology laboratories, funeral parlors, chicken farms, cabinet makers/joineries
- Isocyanates - Crash repairers, cabinet makers/joineries and foam manufacturers
- Rosin Cored Solder Fumes – electronics assembly workplaces
- Western Red Cedar dust – Window frame, door and blinds manufacturers
- Pine Wood dust – Cabinet makers/Joiners using MDF, chipboard, plywood and solid pine
- Animal Dander/Urine - Animal houses
- Wheat Flour Dust – Bakeries and flour mills

A list of relevant workplaces in South Australia was obtained from the Yellow Pages web site and seventy work places were contacted, of those thirty workplaces agreed to participate but only twenty five were visited as the other five organizations never responded to further follow up calls regarding the site visits.

The group of occupational hygienists assessed:

- the effectiveness of control measures based on their experience and knowledge, as well as observations using smoke tubes and other indications
- risk management at the workplaces
- education and training provided to workers

2.3 Findings

Table 4 below shows the total number of employees at the workplaces visited and the number of employees potentially exposed to the relevant asthmagens.

Table 4: Characteristics of participating companies

Case	Industry	No. employees	No. Exposed to agent
1	Woodwork	8	8
2		2	2
3		9	9
4		3	3
5		4	2
6		35	29
7		70	45
8		21	15
9	Automotive	15	10
10		9	7
11		16	1
12		6	3
13	Baking	360	50
14		35	25
15		85	50
16		50	21
17	Electronics	250	30
18		1600	16
19		550	30
20	Scientific / Pathology	4	4
21		13	10
22		17	15
23		30	15
24		45	42
25		20	12

In total, an estimated 3257 workers were employed in the 25 workplaces visited with 454 of these workers being potentially exposed to the relevant asthmagens, based on observation and information provided by managers.

The distribution of organization sizes according to the Australian Bureau of Statistics is shown below in Figure 3.

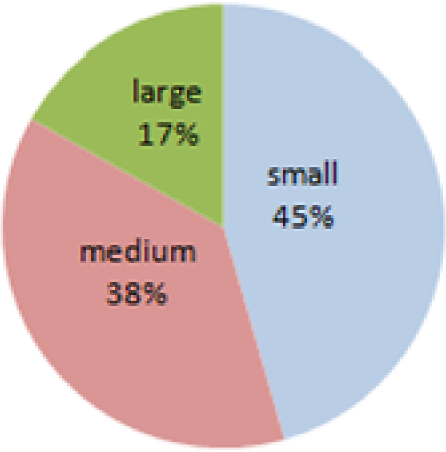

Figure 3: Size distribution of participating companies*

*large=200+ employees; medium=20-199 employees; small=<20 employees. Based on definitions by Australian Bureau of Statistics: http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/1321.0

Table 5 below indicates the range of processes where exposure to the relevant asthmagens was likely.

Table 5: Asthmagenic agents and processes identified

Industry	Asthmagenic agents identified	Processes involving the agent(s)
Woodwork	Wood dust, including western red cedar, jarrah, blackwood, oak, walnut, cedar, meranti, blackbutt, quila, merbau, particleboard (e.g. MDF), plywood; isocyanates	Machining, including saws, mortise and tenon machines, moulders, thicknessers / planers, routers and borers; sanding; spraying (paint/varnish); cleaning
Automotive	Isocyanates	Mixing; spraying; sanding; spray gun washing/cleaning
Baking	Grain dust, flour dust, other ingredients	Milling; unloading; sieving; weighing; filling hopper; adding ingredients; flour dusting (manual or machine); packing; silo maintenance
Electronics	Solder fumes	Various hand and automated soldering processes
Scientific / pathology	Formaldehyde; animal dander, urine and proteins	Embalming, tissue preservation, histopathology, animal handling

2.3.1 Types of controls

The types of controls utilised at the workplaces spanned the hierarchy of controls, although not necessarily following the hierarchy.

The Hierarchy of Controls (in order of priority) are;

- Elimination (eliminate a hazardous substance or process if possible)
- Substitution (substitute a more hazardous substance by a less hazardous substance)
- Isolation
- Engineering controls (e.g. Local Exhaust Ventilation)
- Administrative Controls (job rotation of workers to limit exposure time, standard operating procedures, training)
- Personal Protective Equipment (respirators, gloves, safety glasses hearing protection etc)

2.3.2 Woodwork Industry

There were two types of Local Exhaust Ventilation (LEV) systems found in the workplaces visited. One type was a ducted system that transferred the captured wood dust to an outside hopper/filtration system. The second type was a portable dust extraction unit. For the second type, while the capturing efficiency at the wood dust source was good, the dust was usually collected through a coarse filter located in the work area which appeared to release fine wood dust in the workplace environment. A High Efficiency Particulate Air (HEPA) filter would be more effective as it captures nearly all (99.97%) of the wood dust..

Table 6 below shows that 85% of machining and sanding processes were observed to have one or both types of LEV's mentioned above. In the opinion of the occupational hygienists who visited the sites the LEVs appeared to be average in their effectiveness of minimizing wood dust exposure (1.9 to 2.1 in Table 6). The belt sanding machines appeared to have the least effective LEV due to its design, which provided minimal capturing capacity for wood dust.

Respirator usage by workers during the wood machining and sanding processes was only observed for 22% of the workers. The workers carrying out the wood sanding processes using power tools, appeared to be exposed to the highest wood dust concentrations and in most instances did not have any LEV in place and did not wear respiratory protective equipment. In some workplaces PPE signage was observed to be posted and did not appear to be followed by the workers.

The workers that were supplied with a dust respirator did not always wear it (37%) nor were they always provided with fit testing instructions.
A high number of workers (42%) were not supplied with any respiratory equipment.

Table 6: Woodwork industry controls and effectiveness by process (all companies)

Type of control	Machining (n=50)	Sanding (n=15)	TOTAL (n=65)
Local Exhaust Ventilation			
Used	87%	73%	85%
Effectiveness rating (ave.)*	1.9	2.1	1.9
Respirator usage (PPE):			
Observed (during visit)	24%	13%	22%
Sometimes worn	32%	53%	37%
Not provided	44%	33%	42%

*Rating given by an experienced occupational hygienist: 1=good, 2=average, 3=poor
Note: The data were obtained from 8 companies, each of which had multiple processes with potential asthmagen exposure. In total, 65 processes were assessed

Best Practice Controls

The recommended method of controlling dust emissions from wood working machines entering the workers breathing zone is local exhaust ventilation systems. For these systems to be effective the local exhaust ventilation system duct has to be a close as possible to the source of the dust. Furthermore, the effectiveness of the LEV will be improved with greater enclosure around the source of the dust emissions.

Bench and radial arm saws should have LEV ducts connected to the bottom of the machine and to the top guard (HSE WD02).

The LEV should be ducted and the dust collectors located outside the building.

Portable ventilation systems with capture bags located near the wood work machine will release fine wood particulates into the workplace area unless High Efficiency Particulate Air (HEPA) filters are fitted, nevertheless it is best practice, if possible, to have these capture filters located outside the building.

For belt sanders it is often difficult to have a high level of enclosure for the LEV system, therefore the worker should wear a P2 respirator while using the belt sander.

Ideally portable electric or pneumatic hand sanders should have on-tool extraction fitted, this could either be ducted or connected to a HEPA filtered vacuum cleaner.

Furthermore, P2 respirators should be worn when hand sanding because the LEV is not as effective in capturing all the fine dust generated by this equipment.

Cleaning of equipment and work areas should be carried out using HEPA filtered vacuum cleaner. Brushes, brooms or compressed air should not be used to clean equipment or work areas.

For respirators to be effective, workers should be clean shaven and the respirators selected and fitted tested for the individual. The worker should be shown how to wear the respirator correctly and test for a good fit each time they wear the respirator. If any changes to facial features of workers occurs, then fit testing of respirators should be carried out.

Standard operating procedures should be documented for each task or process carried out in the workplace and training provided for all workers potentially exposed to wood dust.

2.3.3 Automotive Industry

In South Australia there is the regulatory requirement (Part 6 Hazardous Work Division 8 Spray booths) for spray painting using isocyanates to be carried out in a spray booth (some exemptions are given) and that an airline respirator should be used in a spray booth with isocyanates. The quality of the air provided to the airline respirator is also specified in the SA OHS&W Regulations 2010 (Regulation 75).

In Table 7 below it can be seen that spray booths or some form of exhaust ventilation were used in 80% of processes where potential exposure to isocyanates occurred in the automotive repair industries visited. The effectiveness of the local exhaust ventilation systems (Table 7) was rated on the following processes, spray painting, paint mixing and spray gun cleaning. The requirements of the LEV systems for each of these processes were different. The LEV for spray booths was generally good, whereas, the LEV for paint mixing and spray gun cleaning was average to poor.
Respiratory Protective Equipment (RPE) was worn by 87% of the workers observed during the processes mentioned above and during sanding. Note that dry sanding of incompletely cured two pack isocyanate paints can result in workers being exposed to dust containing active isocyanate polymers. In these circumstances wet sanding of the two pack isocyanate painted surfaces is recommended as this will ensure that exposure to active isocyanates is controlled. Airline respirators were worn in all the spray painting processes during the site visits. No respirators were worn during two paint mixing processes (13% in Table 7). All the spray painting respiratory equipment had in-line filtration in order to comply with Australian Standard AS 1715 Appendix A, *"Requirements for Air Quality (Compressed or Cylinders) for Supplied Air Respirators".* However, none of the worksites visited had an air quality testing program as specified in AS1715 Appendix A, to verify that the filtration system was effective.

Fit testing of half-faced and full faced respirators was not a common practice by the management or the workers. .

Table 7: Automotive repair industry controls and effectiveness (all companies)

Type of control	n=15
LEV / spray booth	
Used	80%
Effectiveness rating (ave.)*	2.0
Respirator usage (PPE):	
Observed (during visit)	87%
Not provided	13%

*Rating given by occupational hygienist: 1=good, 2=average, 3=poor

Note: The data were obtained from 4 companies, each of which had multiple processes with potential asthmagen exposure. In total, 15 processes were assessed.

Best Practice Controls

Spray painting of two pack isocyanate based paints should occur in a spray booth with the spray painter wearing an airline respirator.
The spray booth should comply with *AS/NZS 4114.1 (2003) Spray painting booths, designated spray painting areas and paint mixing rooms – Part 1: Design, construction and testing.*
The respiratory equipment worn should be a full face or head covering airline respirator which complies with the specifications of AS/NZS 1715 *Selection, use and maintenance of respiratory protective equipment* and AS/NZS 1716 *Respiratory protective devices*.
At the end of the spray painting session the airline respirator should not be removed or reentry into the spray booth should not occur until the over spray inside the spray booth has cleared.
The clearance time of the spray booth should be measured using a smoke generator to know how quickly two pack isocyanate paint mist clears from the spray booth and to determine if there are any leaks in the spray booth which could release isocyanate paint into the workshop area.
The paint mixing room should be well ventilated and ensure that no sources of ignition no static electricity are present. The need for RPE should be determined by risk assessment of the mixing process, this may depend on the effectiveness of the ventilation system.
Cleaning of spray guns should be carried out in a well-ventilated area with local exhaust ventilation fitted and the worker wearing an airline respirator. Alternatively commercially available automated or manual spray gun washers with local exhaust ventilation can be used.
Nitrile or other suitable chemical resistant gloves should be worn as recommended in the relevant Material Safety Data Sheet (MSDS or SDS) when mixing, spray painting and cleaning the spray gun.
Sanding of two pack isocyanate paint to prepare a surface should be carried out by wet rubbing. Dry sanding should be avoided unless dust extraction equipment on the sander is used together with gloves and P2 dust respirators.
The compressed air provided to the airline respirators should comply with regulation 75 of the SA OHS&W Regulations 2010 and Appendix A of AS/NZS 1715.

(2) If air supplied respiratory equipment is used in the performance of work—
(a) the equipment must supply air at a minimum rate of 170 litres per minute; and
(b) the air must contain not less that 19.5% and not more than 22% oxygen; and
(c) the air must, before reaching the person using the equipment, be passed through—
(i) an efficient purifying device that ensures that the air does not have an objectionable or nauseous odour and, if measured at 15°C and 100 kilopascals, would contain not more than 11 milligrams per cubic metre of carbon monoxide, not more than 900 milligrams per cubic metre of carbon dioxide, and not more than 1 milligram per cubic metre of oil; and
(ii) an efficient conditioner that ensures that the air is supplied at a temperature not less than 15°C and not more than 25°C, and within a humidity range not less than 20% and not more than 85%; and
(iii) an efficient condensate trap that is fitted with a drain cock to remove any condensed liquid; and
(iv) an efficient ring circuit or controlled leak-off system that eliminates stale air.
(3) Any equipment used to supply air to a person for breathing purposes must—
(a) be maintained in efficient working order; and
(b) be kept in a place where it cannot be contaminated; and
(c) be maintained in a way that ensures that the air supply does not overheat; and
(d) incorporate fittings that cannot be connected to any other compressed air equipment at the workplace.
(4) If—
(a) an auxiliary air supply is not provided; and

(b) an inadequacy in the air supply might represent an immediate hazard to the user of equipment used to supply air for breathing purposes,
then an automatic warning device must be used.

2.3.4 Baking/Flour Industries

In bakeries there is the potential for exposure to flour dust in many processes. Wheat flour contains proteins and enzymes which can on exposure lead to respiratory sensitization, known as baker's asthma.
Table 8 below shows that the use of engineering controls or respiratory protective equipment was limited.. Based on observations there was a likelihood that workers were exposed to flour dust during weighing, sieving, flour dusting and cleaning tasks. The respirators observed to be used were half face P2 disposable respirators.

During the workplace visits it appeared that some of the processes where flour was handled had effective exhaust ventilation systems in place e.g. hoppers for transferring flour. However, other processes that did have exhaust ventilation in place, e.g. weighing and sieving, did not appear to be effective in removing flour dust.

The majority of the workers were not provided with respiratory protective devices, which may be a reflection of poor risk management practices or a lack of knowledge in understanding the hazard flour dust exposure potentially poses to the respiratory health of the workers.

Table 8: Baking/flour industry controls and effectiveness (all companies)

Type of control	n=23
LEV	
Used	13%
Effectiveness rating (ave.)*	2.5
PPE usage:	
Observed (during visit)	9%
Sometimes/rarely/never	13%
Not provided	78%

*Rating given by occupational hygienist: 1=good, 2=average, 3=poor

Note: The data were obtained from 4 companies, each of which had multiple processes with potential flour exposure. In total, 23 processes were assessed.

Best Practice Controls

Sieving units should have dust extraction systems fitted.
Hopper outlets should be enclosed
Top rim dust extraction on mixers should be used if flour and other ingredients are added manually.
Brushes or dry sweeping should not be used for spilled flour. If flour spillages occur a HEPA filtered vacuum cleaner should be used to collected the flour dust.
Local exhaust ventilation systems with partial enclosure should be used for weighing out dry ingredients.
Use sprinklers to spread flour dust rather than throwing the flour by hand.
Avoid using compressed air for cleaning equipment or other items.
Wear a P1 or P2 dust respirator for dusty tasks as determined by risk assessment of the tasks. The worker should not have facial hair and have the respirator fit tested prior to use.

2.3.5 Electronics Industry

In the electronics industries, rosin cored lead/tin solders are commonly used to connect wires or other connections to circuits during the assembly of electronic boards.
Table 9 below shows that in the electronics industries visited where rosin cored solders were utilised, all processes seen used some form of local exhaust ventilation to control exposure to the rosin fume. The effectiveness of the LEV was better than average. It should be noted that there is no requirement to wear a respirator where an effective LEV is operating. Respiratory protective equipment was observed to be used for only one process.

Table 9: Electronics industry controls and effectiveness (all companies)

Type of control	Number of Processes n=5
LEV	
Used	100%
Effectiveness rating (ave.)*	1.8
PPE usage:	
Observed (during visit)	0%
Sometimes/rarely/never	20%
Not provided	80%

*Rating given by occupational hygienist: 1=good, 2=average, 3=poor

Note: The data were obtained from 3 companies, each of which had multiple processes with potential asthmagen exposure. In total, 5 processes were assessed.

Local exhaust ventilation systems were used to control exposure to rosin fume for all processes in the electronics industries visited compared to the other industries / workplaces.

Best Practice Controls

Automated soldering equipment can be enclosed and local exhaust ventilation fitted to remove the solder flux fumes from the enclosure of the process.
For manual soldering processes the use of flexible arm exhaust ventilation provides good local exhaust ventilation as long as the capture hood is close to the soldering process and the general air movement in the area is not so great as to affect capture of the soldering fumes.
Using a narrow bore tube on the iron itself to capture fume at source is known as tip extraction. The tube (in the range 4-12 mm diameter) is either clipped to a normal iron or incorporated in a purpose-made iron. The location of the extraction tip and the capturing velocity is critical to effectively capture the solder fumes.
Partial enclosure which contains the source of the solder fumes. Sufficient airflow needs to be provided to draw the contaminant away, and prevent it escaping from inside the hood, then effective control can be achieved. The cabinet should be made of transparent material so that the worker can see what they are doing. The minimum average air velocity over the opening needs to be 0.5 metres per second.

2.3.6. Scientific / Pathology Workplaces

In pathology workplaces a 5% formaldehyde (formalin) solutions were usually used to preserved tissue specimens for pathology work. Workers were potentially exposed to formaldehyde during handling and cut up of the tissues samples and less frequently but to higher exposures during disposal of tissue specimen samples.

In the pathology workplaces the cut up of tissue specimens was usually carried out next to an LEV system which in the opinion of the occupational hygienist appeared to be very effective. The process of disposal of specimens was observed at one workplace and the workers wore respiratory protective devices, however, this process was not observed at other workplaces as it is not carried out daily.

Table 10: Scientific/pathology industry controls and effectiveness (all companies)

Type of control	n=9
LEV	
Used	89%
Effectiveness rating (ave.)*	1.9
Respirator usage:	
Observed (during visit)	0%
Sometimes/rarely/never	22%
Not provided	78%

*Rating given by occupational hygienist: 1=good, 2=average, 3=poor

Note: The data were obtained from 6 companies, each of which had multiple processes with potential asthmagen exposure. In total, 9 processes were assessed.

Best Practice Controls

The use of a fume cupboard will provide good control of exposure to formaldehyde for all tasks carried out in the laboratory.
Use a partially enclosed local exhaust ventilation system for tissue specimen cut up.
A multi slot hood set up with partial enclosure should control formaldehyde given that the specimen

preparation areas are as close as possible to the slot hood openings.
Wear a half face or full face respirator fitted with formaldehyde cartridges when disposing of specimens.

2.4 Knowledge, Training and Administrative Controls

Discussions were held with managers, and questions were asked in relation to personal knowledge of health effects, information provided to employees, and risk management strategies.

Table 11 below indicates that only about one third of the managers had a good knowledge of the relevant asthmagen.

Table 11 Managers Knowledge of the health effects of the asthmagens

Managers' knowledge about effects of agent	Percentage
good	32%
limited	64%
none	4%

Table 12 Information provided to employees about asthmagens

Information about asthma provided to employees	Percentage
yes	20%
limited	58%
no	22%

While 20% of workplaces reported they were provided with information about the relevant asthmagen used, most workplaces appeared to only provide limited or no information to the workers.

In 20% of workplaces visited, it was reported that risk assessments for exposure to the asthmagens had been carried out and documented. Some workplaces had carried out plant risk assessments and considered these to be a satisfactory risk assessment for the relevant asthmagen. The lowest rate of risk assessments was reported in the Woodwork Industry workplaces surveyed.

It should be noted that the use of Respiratory Protective Equipment (RPE) requires fit testing of the respirator and knowledge of this requirements appeared to be limited at the workplaces, in particular the Woodworking Industries.

Table 13: Risk Assessments and Training

Risk assessments conducted	48%
Provide training on relevant controls	61%
Fit-testing conducted (if PPE used)	43%

Shown in Table 13 above are the results obtained from the survey which indicated that for the workplaces visited, only 48% had a risk assessment conducted with 61% of the workplaces providing training regarding the type of controls used. Furthermore only 43% of the workplaces where RPE was used carried out any fit testing of respirators.

2.5 Discussion

One of the issues in attempting to establish how workplaces deal with asthmagens was their willingness to participate in the survey. Of the seventy workplaces contacted where exposure to asthmagens could occur, only thirty indicated they were willing to participate in the site visit questionnaire survey. With only thirty of the businesses contacted willing to participate a self selection bias may be introduced in that the workplaces that participate are either more interested in the health of their workers and so are willing to participate in the survey or they believe they are managing the health and safety of the workers effectively.

To obtain an unbiased and more representative view of workplace controls and practices, including small, medium and large industries, the involvement of occupational health and safety inspectors in future surveys would be beneficial.

Another issue that may play a role in the composition of the workforce exposed to these asthmagens is the "healthy worker survivor effect" which is a process by which those who remain employed in these workplaces tend to be healthier than those who leave employment - that is they are more tolerant to the effects of exposure to the relevant asthmagens.

The hierarchy of controls should be followed to ensure exposure to contaminants, in this case asthmagens, is minimised. The elimination or substitution of the relevant asthmagens is not possible in the case of the asthmagens considered as for example it would be impossible to make a wheat flour based bread without using any wheat flour. Therefore, isolation and engineering controls are the highest level of control that can be effectively used to minimize exposure, followed by administrative controls and then Personal Protective Equipment (PPE), the last resort, which can be used together with the other higher levels of control.
Heederik (2012) reviewed 29 studies and found that exposure elimination is the strongest and preferred primary prevention approach to reduce the burden of occupational asthma. Exposure reduction is the second best option to prevent occupational asthma, for example using engineering controls and respiratory protection. The authors concluded that there is little direct evidence in the literature that respirators are effective for the primary prevention of occupational asthma. However, the use of respiratory protective equipment when used together with higher levels of control can contribute to primary prevention of occupational asthma.

In the woodworking industries, most workplaces had LEV systems fitted. However, the filter bag type which was usually located inside the work area is likely to release fine wood dust into the work area rather than capture the dust and thus expose workers to respirable wood dust. The use of RPE while sanding wood which presents a high risk of wood dust exposure did not appear to be well controlled as very few workers wore respirators.

For the two pack isocyanate based paints used by crash repairers most workplaces used a spray booth and airline respirator for spray painting, however other process where handling of the isocyanate occurred (mixing, spray gun cleaning) exposure appeared to be less well controlled. Furthermore the quality of the air used in the airline respirators did not appear to be tested.

In the pathology area formaldehyde exposure appeared to be well controlled during processing of tissue specimens. However, during disposal of the tissue samples there appears to be an increased level of exposure.

The animal house visited was well controlled and potential employees are screened for agents likely to be encountered in the workplace and the test results considered before a person was employed. The workplace was kept clean and PPE (gloves and respirator lab coat) were worn.

There are other chemicals and physical agents associated with work exacerbated asthma (Lemiere etal (2012)) which may need to be considered in future work place site visits and risk assessments. These chemical and physical agents are likely to be irritants which may be a nuisance to normal individuals at low concentrations, but can cause significant health problems such as asthma attacks when sensitive individuals are exposed to these levels.

Documented health based risk assessments for potential exposure to asthmagens were generally not well done, this is somewhat surprising considering that the Hazardous Substances Regulations have been in force since 1995.

The results of the site visit survey/ observations appear to indicate that while training in the use controls to manage exposure to asthmagens was provided by 61% of the workplaces, only 20% of workers were given information about asthma while the rest were provided with limited or no information.

The current regulations require knowledge of the hazards associated with working with hazardous substances. Consistent with the lack of risk assessments being conducted, the limited health knowledge of the relevant asthmagens reported by management and workers is not a surprise. Our observations would suggest that there appears to be an inadvertent lack of awareness of the adverse health issues associated with exposure to the relevant asthmagens as they do not pose an immediate problem (like safety issues).

The use of engineering controls is the preferred method of control to be used to control exposure to the asthmagens, however practicability becomes a factor as effective well designed engineering controls can be costly compared with the relatively cheap capital cost of purchasing respiratory protective devices.

While most workplaces had some form of engineering controls, in some workplaces they did not appear to be well designed or well maintained for the particular hazard and process. A lack of knowledge regarding use and fit testing of respiratory protective equipment was also evident from the workplace survey visits.

It should be noted that this was a pilot study to test whether a hazard surveillance project was possible to identify the current state of exposure and control to asthmagens and assist workplaces in preventing occupational asthma. The main limitation of this pilot project has been the difficulty in selecting an unbiased group of workplaces and getting workplaces to participate in the project. In the future a scientifically acceptable approach to a hazard surveillance project would be to involve the regulators together with occupational hygienists in order to obtain an unbiased selection of workplaces to visit. This is an important component as a good database of representative workplaces is required for future follow up of the workplaces. The UK Health and Safety Executive uses specialist inspectors and a purposive sampling strategy,

The critical elements of a Hazard Surveillance Project should be;

- Obtaining a representative sample of workplaces covering different sizes of the workforce
- Preparation of a survey instrument
- Measuring exposures to the hazards
- Evaluating exposure data
- Assessing the effectiveness of controls, including training
- Feedback on the findings and recommendations of the survey to the workplaces
- Follow up surveys at regular intervals to determine if improvements have been achieved.

Part 3 NATIONAL ADVICE AND RECOMMENDATIONS

3.1 Needs Analysis and National Advice

Overview

Although this was a pilot study, the consensus view of an expert panel of practising hygienists is summarized in the Table below[2]. Deficiencies were evident with respect to administrative controls and personal protection in woodworking and flour handling processes.

Table 14: Hazard control needs analysis by asthmagen category

Control	**Woodwork**	**Isocyanates**	**Flour dust**	**Soldering fume**	**Pathology/ Formaldehyde**
Engineering (e.g. LEV)	+-	+-	+-	+	+-
Administrative (e.g. training)	--	--	--	+ -	+
PPE respiratory protective equipment	--	+	--	+	+-

+ indicates adequate control measures at the workplaces
+- Controls were in use but some were not very effective.
-- indicates inadequate control measures and improvements required at workplaces

Commentary

For woodwork, local exhaust ventilation systems were used, however for some tasks the LEVs used were ineffective or the LEV systems did not capture the fine wood dust. Training on the health effects of the asthmagen and Standard Operating Procedures (SOPs) were not carried out in many workplaces. Training and documentation of health based risk assessments was inadequate as safety considerations were looked at but not health hazards. PPE was not always worn during dusty tasks and when LEVs were not effective. Fit testing of respirators was not always carried out.

The automotive industry companies using two pack isocyanate based paints appear to have efficient local exhaust ventilated (LEV) spray booths for spray painting, however, for other tasks where exposure to isocyanates could occur such as gun washing and paint mixing the LEV could be improved. Training and documentation of health based risk assessments appeared inadequate. The use of airline respirators was a mandatory requirement and appeared to be appropriate for the spray painting task. Respirators were not always worn during sanding tasks where exposure to partly cured isocyanates was possible.

For workplaces using flour the LEV systems were effective for some tasks involving large hoppers and flour transfer to mixing containers. However, there were several operations such as sieving and weighing which appeared to be less well controlled. Engineering controls appeared to be better in larger workplaces where flour was used. Training and documentation of health based risk assessments appeared inadequate. Respirators did not appear to be provided in many workplaces visited or were not

[2] Table 14 reflects the state of control use in the sites visited based on occupational hygiene experience and expertise. However, this sample of the industry groups may not be representative of all industries due to a possible self selection bias.

worn during tasks such as sweeping and maintenance.

In the limited number of electronics industry workplaces visited the LEV controls were adequate. In most workplaces there did not appear to be a requirement to wear respirators as effective LEV systems were operating. However, training and documentation of health based risk assessments appeared inadequate.

Scientific pathology workplaces had LEV systems close to specimen preparation areas, which in the opinion of the occupational hygienist appeared to be very effective. However, the disposal of specimens could be better controlled using LEV systems. Administrative controls appeared to be effective. For many processes, no respirators were required as the LEV system controlled exposure to formaldehyde.

Advice

The following advice aligns with the Australian Strategy Action Areas and Strategic Outcomes to be achieved by 2022.

1. Action Area - *Health and safety by design.*

Action should be taken to improve hazard isolation strategies and engineering controls. e.g. local exhaust ventilation systems will help to minimize exposure to asthmagens and minimize the risk to workers.

2. Action Area - *Health and safety capabilities.*

Action should be taken to train workers and managers about health effects, controls and their maintenance. e.g. Where personal respiratory protection is used, training will help in correct selection, use and maintenance.

3. Action Area – *Research and Evaluation*

Action should be taken to gather and consolidate exposure data for better prioritization of interventions. e.g. the evidence from this hazard surveillance study and future recommended studies should be used to drive changes in workplaces to minimize exposure.

3.2 Recommendations:

1. **The Safe Work Australia website should provide best practice information on the prevention of occupational asthma**

The UK Health and Safety Executive has developed a range of high quality asthma prevention resources that can be "Australianised". This information, along with local information, should be compiled and made available on the Safe Work Australia website.

2. **WHS authorities should implement a targeted awareness campaign, in conjunction with industry, followed by a regulatory campaign.**

An awareness campaign, referencing the abovementioned resources, should be implemented, followed up by a regulatory campaign focussing on the provision of health information, and the selection and use of ventilation systems and respiratory protective equipment. The awareness campaign can be in the form of roadshows, with the engagement of industry associations.

3. **A system of hazard control intelligence should be established.**

A larger-scale purposive survey of small, medium and large companies should be undertaken, with a repeat survey within the life of the current Australian Work Health and Safety Strategy. Workplace inspectors should accompany experienced hygienists, to assure access to workplaces. This hazard control "intelligence", in conjunction with reviews of disease surveillance data, will enable better targeting of efforts for the prevention of occupational asthma, as well as other diseases of short to medium latency. It will also enable international benchmarking.
The UK has been a leader in asthma prevention efforts, and it appears from a recently published[3] paper that the interventions applied in the motor vehicle repair industry are having success in reducing isocyanate exposures in that industry.

[3] Jones K., Cocker J., Piney M. Isocyanate exposure control in motor vehicle paint spraying: Evidence from biological monitoring. *Ann Occup Hyg.,* 57(2): 200 -209 (2013)

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