Investigation of a reported cluster of cancer cases at the National Gallery of Australia

Final report

Report to the National Gallery

Tim Driscoll
Gary Foster
Felicity Driscoll

ELMATOM Pty Ltd

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BACKGROUND OF THE PROJECT TEAM

This report was prepared by Dr Tim Driscoll (MBBS BSc(Med) MOHS PhD FAFOEM FAFPHM), Mr Gary Foster (BSc MSc) and Ms Felicity Driscoll (BA). Dr Driscoll is an independent consultant in epidemiology, occupational health and public health. Dr Driscoll is a specialist in occupational medicine and public health medicine. He is also a fellow of the Australasian Faculty of Occupational and Environmental Medicine and the Australasian Faculty of Public Health Medicine. Mr Foster is a consultant occupational hygienist and a member of the Australian Industrial Hygiene Association. Ms Felicity Driscoll was the research officer working on the project.

ACKNOWLEDGEMENTS

Many people and organisations provided important assistance to the authors in the conduct of this project and their contribution is hereby acknowledged. The Human Research Ethics Committees of the University of Sydney, of each of the State and Territory Cancer Registries and of the Australian Institute of Health and Welfare National Cancer Statistics Clearing House and National Death Index provided ethics clearance. The State and Territory Registrars of Births, Deaths and Marriages gave permission to use their data on cancer notifications. Officers of the Australian Institute of Health and Welfare provided information on cancer notifications and death notifications, as well as advice on obtaining and using the AIHW data. In particular, the authors would like to thank Ms Kun Zhang and Mr John Harding in this regard. Mr Kevin McGeechan of the School of Public Health, University of Sydney, provided helpful advice on analytical approaches. The authors would like to thank all the current and past employees of the National Gallery of Australia who have contributed to the project by providing information and other assistance. They would also like to thank the members of the Steering Committee for their assistance and constructive guidance, and in particular Ms Melinda Carlisle, Mr Tony Rhynehart and Mr Darrel Lord for their assistance over the course of the project.

GLOSSARY

A/m	Amperes per metre
AHU	Air handling unit
AIHW	Australian Institute of Health and Welfare
fibre/ml	Fibre per millimetre
IARC	International Agency of Cancer Research
mg/m^3	Milligrams per cubic metre
MDF	Medium density fibreboard
MPDL	Minimum Practical Detection Limit
MSDS	Material Safety Data Sheet
NCSCH	National Cancer Statistics Clearing House
NHMRC	National Health and Medical Research Council
NOHSC	National Occupational Health and safety Commission
OHS	Occupational health and safety
ppm	Parts per million
s.d.	Standard deviation
SIR	Standardised Incidence Ratio
STEL	Short term exposure limit - a 15 minute TWA exposure which should not be exceeded at any time during a working day
TWA	Time Weighted Average (usually averaged over 8-hours)
μT	Microtesla
VOCs	Volatile organic compounds

EXECUTIVE SUMMARY

BACKGROUND

Concern regarding a possible work-related cancer cluster amongst National Gallery of Australia (the Gallery) staff arose following a review of sick leave in February 2002 in which an apparent cluster of cancer illnesses amongst security staff was identified. A few months later an investigation of the matter was undertaken by an occupational physician, who concluded in a short report that there was no unusual occurrence of illness and that "Considering the epidemiological issues, it is in my opinion exceedingly unlikely that there is any occupational cancer causing-agent responsible for this cluster of illness". An independent investigator later reviewed the report and raised some methodological issues regarding it. The Gallery therefore commissioned a second, more detailed study of the apparent cancer cluster amongst Gallery staff members. That study commenced in July 2006 and is reported here.

The study reported here was divided into two overlapping aspects. One involved considering past and current exposures to carcinogens in the Gallery. This was considered Stage One of the project and was largely completed in early 2007, although some further relevant work has been undertaken since the release of the Stage One report. The other aspect, Stage Two of the project, involved an epidemiological assessment of the occurrence of cancer in past and current Gallery employees which focussed on identifying the cases and assessing the likelihood that the number of observed cases was greater than would be expected given cancer rates in the general community. This involved matching the names of current and former staff to information held by State and Territory cancer registries.

This is the final report on the project. It covers both stages of the investigation.

METHODS

Information on exposure was collected during trips to Canberra in September, October, November, and December 2006, and January and March 2007. The information came from discussions with current and former staff, site inspections and review of the reports from previous investigations and other relevant documentation.

Information on cancers in current and former staff members came from the National Cancer Statistics Clearing House (NCSCH) of the Australian Institute of Health and Welfare (AIHW) and information on deaths came from the National Deaths Index of the AIHW. The study covered incident (new) cancers that were diagnosed from soon after the Gallery building was occupied (1st January 1982) to the most recent time covered by the NCSCH (31st December 2004 inclusive).

FINDINGS

A number of potential exposures to definite or suspected carcinogens were identified. None of these exposures seem likely to have been high enough to have meaningfully increased the risk of Gallery staff members, volunteers or members of the public developing cancer. In relation to nearly all the relevant exposures, the occupational health and safety procedures and practices seem to have been appropriate. The possible exceptions to these were exposure to diesel exhaust as a result of trucks delivering and picking up cargo, and the storage of potentially carcinogenic pigments in the Conservation Department. Both these issues have been addressed by the Gallery and actual exposures do not seem to have ever been at a worrying level. The assessment of past exposures was able to be made with reasonable confidence. Nevertheless, some uncertainty remained due to limited information on the nature of some exposures.

Fifty-seven current and former staff members were diagnosed with eligible cancers during the study period. Six people had two eligible cancers diagnosed, resulting in a total of sixty-three eligible cancers that could be included in the analysis. There were many different cancer types identified, and the types that were most common among employees (breast cancer, colo-rectal (bowel) cancer, lung cancer, prostate cancer and melanoma) were the cancer types most common in the general community. The expected number of cases for this population, based on Australian cancer rates and taking into account differences in age and gender, was 73.5, giving a Standardised Incidence Ratio of 0.86 (95% confidence interval = 0.66 – 1.10). This means the rate of cancer in Gallery workers was 14% lower than the rate in the Australian population. The Standardised Incidence Ratio for some specific cancers was higher than the Australian rate, and for some cancers was lower than the Australian rate. However, the statistical tests that were conducted suggest that the differences in the rates (both the higher rates and the lower rates) could easily have been due to chance. For security officers, the estimated rate for all cancers was 23% per higher than the Australian rate, but this apparent increase also may well have been due to chance. The analysis suggests that the rate of bowel cancer in security officers may have truly been higher than the comparable rate in the Australian population, but there is little to suggest that the apparent increase in risk is related in any way to work-related exposures at the Gallery.

CONCLUSIONS

This study investigated past and current carcinogenic exposures at the Gallery, and cancers that occurred in Gallery staff members. There do not appear to have been any exposures at the Gallery that would be expected to have meaningfully increased the risk of developing cancer of any form. The characteristics and rate of cancers identified in Gallery staff members were consistent with those in the general community. Therefore, it is very unlikely that any of the cancers identified in Gallery staff members were related to exposures experienced while working in the Gallery building. No further investigation of this issue is considered necessary.

OVERALL SUMMARY OF THE REASONS FOR THE STUDY FINDINGS

The three key issues that needed to be answered by this investigation were:

- Are there known workplace exposures that could have contributed to the occurrence of the cancers in Gallery employees?
- Is there truly an increased risk of cancer amongst current and former employees at the Gallery?
- If so, is there evidence that this high rate is due to exposures associated with work at the Gallery.

To address these issues, answers to a series of specific questions provide a useful guide.

ARE THERE KNOWN WORKPLACE EXPOSURES THAT COULD HAVE CONTRIBUTED TO THE OCCURRENCE OF THE CANCERS?

The exposure assessment identified a number of potential exposures to definite or suspected carcinogens. From the available evidence, none of these exposures seem likely to have been high enough to have meaningfully increased the risk of Gallery staff members, or members of the public, developing cancer. In relation to nearly all the relevant exposures, the occupational health and safety procedures and practices seem to have been appropriate. The possible exceptions to these were exposure to diesel exhaust as a result of trucks delivering and picking up cargo, and the storage of potentially carcinogenic pigments in the Conservation Department. Both these issues have been addressed by the Gallery and actual exposures do not seem to have ever been at a level that raises concern about long-term health issues. The assessment of past exposures was able to be made with reasonable confidence. Nevertheless, some uncertainty remained due to limited information on the nature of some exposures.

HAVE ALL THE CASES BEEN IDENTIFIED?

It is likely that nearly all relevant cases have been identified.

Comment: A small number of eligible cases may have been missed due to inadequate data and lack of consent from employees, but it is expected that nearly all cases have been identified. It is unlikely that the number or type of missing cases would change any conclusions made as a result of the study findings.

ARE ALL THE CASES OF THE SAME (OR SIMILAR) TYPE?

No

Comment: There were many different cancer types identified, and the cancer types most common among employees were the cancer types most common in the general community.

IS THERE STATISTICAL EVIDENCE TO SUGGEST THAT THE NUMBER OF CASES IS IN EXCESS OF WHAT WOULD BE EXPECTED IN THIS POPULATION?

There is no strong evidence that the rate of cancer in Gallery employees is different to the rate of cancer in all Australians. The evidence suggests any difference present is due to chance. The one possible exception is the rate of bowel cancer in security officers, which may have truly been higher than the rate in the general Australian community.

Comment: The estimated rate for all cancers for all workers at the Gallery was 14% lower than the Australian rate, taking into account differences in age and gender. The estimated rate for some specific cancers was higher than the Australian rate, and for some cancers was lower than the Australian rate. The statistical tests that were conducted suggest that the differences in the rates (both the higher rates and the lower rates) could well be due to chance. In addition, these tests do not take into account the problems of statistical testing in cluster investigations. If they did, the statistical tests would provide even less evidence that the Gallery employees truly have a higher rate than the general population. The rate for bowel cancer in security officers was the only rate for which the confidence interval suggested there might be a true underlying difference compared to the Australian population. However, this is difficult to determine confidently because of the low number of cases and the problems inherent in interpreting statistical tests in a cluster investigation.

DO THE CANCER TYPES HAVE A KNOWN COMMON CAUSE, WHETHER OCCUPATIONAL OR NON-OCCUPATIONAL?

There are no common occupational causative exposures to most of the identified cancer types. Various lifestyle factors are related to a number of the identified cancer types.

Comment: The five most common cancers in Gallery employees were the same as the five most common cancers in the Australian population. There have not been any relevant exposures identified at the Gallery that would be expected to meaningfully increase the risk of developing any of the cancers identified in Gallery staff members.

DID THE PERSONS DIAGNOSED WITH CANCER HAVE A COMMON OCCUPATIONAL (OR NON-OCCUPATIONAL) EXPOSURE?

The only known common occupational exposure of the persons with the identified cancers is work in the Gallery building.

DID THE CANCERS OCCUR AT AN APPROPRIATE TIME IN RELATION TO THE POSSIBLE WORKPLACE EXPOSURES?

Many did.

Comment: Cancer usually takes many years after an exposure to develop enough to be diagnosed. This period between exposure and diagnosis, called the latency period, is typically of the order of five, ten or fifteen years at least, but for some exposures can be as long as thirty or forty years. Forty per cent of the cancers were diagnosed ten or more years after the person commenced work in the Gallery building.

ARE THERE ANY PLAUSIBLE NON-OCCUPATIONAL CAUSES FOR THE SUSPECTED CLUSTER?

There are many, but they were not investigated in this study.

Comment: The non-occupational risk factors for the cases were not investigated. Since the five most common cancers in Gallery employees were the same as the five most common cancers in the Australian population, this suggests that there was nothing unusual about the exposures of the Gallery employees. Various lifestyle and personal factors are related to a number of the identified cancer types and are the most common contributing exposures to these types of cancer in the general community.

ON THE BALANCE OF PROBABILITIES, IS IT LIKELY THAT THE IDENTIFIED CANCERS OCCURRED AS A RESULT OF OCCUPATIONAL EXPOSURES?

On the balance of probabilities, it appears highly unlikely that the cases of cancer diagnosed in current and previous workers at the National Gallery were in any way related to occupational exposures experienced whilst working in the building. There have not been any relevant exposures identified at the Gallery that would be expected to meaningfully increase the risk of developing any of the cancers identified in Gallery staff members, and there is nothing unusual about the type, age of onset or rate of cancers identified in Gallery employees compared to cancers in the Australian community. The one exception in terms of rate is bowel cancer in security officers, but the apparent increased rate of bowel cancer in security officers is very unlikely to be related to work-related exposures at the Gallery.

SUMMARY

This study investigated past and current carcinogenic exposures at the Gallery, and cancers that occurred in Gallery staff members. There do not appear to have been any exposures at the Gallery that would be expected to have meaningfully increased the risk of developing cancer. The characteristics and rate of cancers identified in Gallery staff members are consistent with those in the general community. Therefore, it is very unlikely that any of the cancers identified in Gallery staff members were related to exposures experienced while working in the Gallery building. No further investigation of this issue is considered necessary.

RECOMMENDATIONS

Recommendations arising from the first stage of this investigation were presented in the Stage One report. They are repeated in full, along with the Gallery response, in Chapter 12. Some of these recommendations are still relevant and some were specific to the time when they were made. The on-going recommendations are presented here, along with the new recommendations arising from completion of the investigation.

Asbestos

Follow the recommendations of the January 2007 asbestos management plan, including referring to the relevant procedures when new or maintenance work is being undertaken and labelling asbestos-containing material.

Cadmium, carbon black, cobalt, magenta

Continue to store glass containers on the shelf such that they cannot be knocked over and the labels are more easily read.

Continue using a fume cupboard when decanting bulk pigment powders.

Formaldehyde

Ensure that medium density fibreboard (MDF) panels in exhibits are sealed. If irritation occurs, a respirator designed for formaldehyde exposure should be used. Advice on this should be sought from respirator suppliers. Dust particulate masks, Class P1, should adequately reduce exposure to dust from MDF but not necessarily to formaldehyde vapour. These masks will reduce exposure to formaldehyde which is adsorbed onto dust particles.

Wood dust

Continue to wear P1 dust respirator when likely to be exposed to wood dust.

Diesel fumes

The loading dock should be designed so that it is isolated from areas occupied by staff once the new extension and renovation of the building are completed. Alternatively, exhaust ventilation could be fitted to the loading dock to capture the exhaust fumes.

Some form of exhaust ventilation appears to be warranted as an interim measure while the new extension is being planned and built. The practicalities of installing such ventilation as a short-term measure in the current building should be investigated by the Gallery.

In addition, it would be appropriate to formally inform (in writing) all delivery drivers and contractors of the importance of turning off their truck engines when stopped in the loading dock. This requirement should be rigorously enforced by Gallery staff members responsible for receiving or sending goods via the delivery and loading docks.

Extremely low-frequency electro-magnetic fields

Routine monitoring of electromagnetic fields is probably not warranted. However, it would be wise to repeat the measurements in and around the security control room any time there is a significant change in electrical equipment in the security control room.

Risk assessment

Complete and maintain the risk assessment of hazardous substances and exposures, including comprehensive documentation of material safety data sheets, worker training, record keeping, and proper labelling, storage and disposal.

Dissemination of the study findings

The final report of the study should be made available to the past and present employees and the general public. This is probably best achieved by placing a copy of the report on the Gallery web site and writing to past employees informing them of the completion of the study and the whereabouts of the report on the web site.

Further investigations

No further investigation of the concern regarding work-related cancer at the National Gallery of Australia is considered necessary. Any subsequent concerns about this or other occupational health and safety issues amongst Gallery staff members should be responded to promptly and comprehensively.

1. INTRODUCTION

1.1 BACKGROUND

Concern regarding a possible work-related cancer cluster amongst National Gallery of Australia (Gallery) staff arose following a February 2002 review of sick leave undertaken by the Gallery's HRM Department. This review identified an apparent cluster of cancer illnesses amongst security staff. A few months later an investigation of the matter was undertaken by an occupational physician employed by Health Services Australia, who concluded in a short report that there was no unusual occurrence of illness and that "Considering the epidemiological issues, it is in my opinion exceedingly unlikely that there is any occupational cancer causing-agent responsible for this cluster of illness".

Other occupational health and safety concerns had been raised at the Gallery over a number of years, and there have been several investigations and reports regarding various occupational health and safety and related matters at the Gallery. One of these investigations was conducted by a Comcare Investigator, Mr Robert Wray. Amongst other issues, Mr Wray reviewed the report by Health Services Australia and raised some methodological issues regarding the report. Mr Wray recommended that "…Another expert opinion be sought on the possible association of security staff cancer illnesses with the NGA environment". In accepting this recommendation, the Gallery determined that the second expert opinion should extend to cover all staff of the Gallery, and not be confined just to Security staff.

The Gallery therefore commissioned a second, more detailed study of the apparent cancer cluster amongst Gallery staff members. The project required an epidemiological assessment of the cluster, but this needed to be as thorough as was reasonably possible and made in the context of other relevant occupational health and safety issues at the Gallery. This should be the case in most cluster investigations, but it was particularly important in this instance, given the apparent concerns regarding an inadequate investigation previously and the broader, long-running criticisms of occupational health and safety at the Gallery for many years. It was also considered very important to involve all interested parties in the project, so that all concerns were heard and addressed as much as was reasonably possible.

There are a number of approaches that can reasonably be taken when investigating an apparent cancer cluster, and many references that provide good guidance in this regard[1-5]. Recurring themes in these publications are that:

- such investigations commonly do not provide a definitive answer;
- most apparent clusters are almost certainly chance occurrences of cancers due to non-work exposures;
- a small number of cluster investigations have identified important relationships between work-related exposures and cancer;
- investigation requires a careful and considered approach; and
- dismissing apparent clusters without appropriate investigation, consideration and consultation is likely to result in the acrimony of concerned staff and the escalation of tension and worries in the affected workforce.

Key questions that needed to be answered were used as the basis for the methodology used in the project. The questions were:

- Are there known workplace exposures that could have contributed to the occurrence of the cancers?
- Have all the cases been identified?
- Are all the cases of the same (or similar) type?
- Is there statistical evidence to suggest that the number of cases is in excess of what would be expected in this population?
- Do the cancer types have a known common cause, whether occupational or non-occupational?
- Did the persons diagnosed with cancer have a common occupational (or non-occupational) exposure?
- Did the cancers occur at an appropriate time in relation to the possible workplace exposures?
- On the balance of probabilities, is it likely that the identified cancers occurred as a result of occupational exposures?
- Are there any plausible non-occupational causes for the apparent cluster?

The project was divided into two overlapping aspects. One involved considering past and current exposures to carcinogens in the Gallery. This was considered Stage 1 of the project. The other aspect, Stage 2 of the project, involved an epidemiological assessment of the occurrence of cancer in past and current Gallery employees which focussed on identifying the cases and assessing the likelihood that the observed cases were more than would be expected given cancer rates in the general community. This involved matching the names of current and former staff to information held by State and Territory cancer registries.

1.2 Terms of reference

The agreed Terms of Reference of the investigation for the entire project were:

1. In relation to current and former staff and volunteers, provide an opinion on the likelihood of any work-related contribution to the already identified cases of cancer and any other cases of cancer identified during the investigation. [Note: the investigation will not provide an assessment of individual cases].

2. Without limiting the investigation, the project will include:

(a) an assessment of past exposures to physical, chemical or biological hazards.

(b) an assessment of current exposures to physical, chemical or biological hazards.

(c) examination of the issues raised by staff in their response to the Gallery's requests made in March 2005.

(d) examination of other relevant matters raised by Gallery staff members during the conduct of the investigation.

3. Recommend appropriate action.

Scope: The investigation is to include all staff and volunteers who have been employed by the Gallery since the Gallery opened in October 1982.

1.2 PROJECT AIMS

The main objectives of the study were to:

- provide an opinion on the likelihood of any work-related contribution to the identified cases of cancer (and any other cases of cancer in any Gallery staff members (not just security officers) identified during the project); and
- recommend what, if any, further action might be warranted.

1.3 COVERAGE AND STRUCTURE OF THE REPORT

This is the final report on the project. It covers both stages of the investigation. The report has 14 chapters. The Introduction provides information on the background to the investigation being set up and the agreed scope of the investigation. Chapter 2 describes the methods used to obtain information. Chapters 3, 4 and 5 consider respectively definite, probable and possible carcinogenic exposures at the Gallery. Chapter 6 provides a brief overview of occupational health and safety policies and procedures relevant to carcinogens. Other exposures and exposure incidents of note that have some potential relevance to the consideration of carcinogenic exposures are discussed in Chapter 7.

Chapter 8 discusses the findings of the exposure review, Chapter 9 describes the epidemiological analysis, Chapter 10 provides a discussion of the epidemiological analysis and Chapter 11 provides a comment on other aspects of occupational health and safety in the Gallery building. Chapter 12 presents the recommendations, Chapter 13 provides conclusions and Chapter 14 provides a list of references. Other relevant information is presented in the appendices.

2. METHODS

2.1 INTRODUCTION

The focus of this investigation was cancer and the exposures that can cause it. Cancer usually takes many years after an exposure to develop enough to be diagnosed. This period between exposure and diagnosis, called the latency period, is typically of the order of ten to fifteen years at least, but for some exposures can be as long as thirty or forty years. This means, for example, that cancers that occurred in Gallery staff members since the year 2000 would, if they had resulted from work-related exposures, most likely have been due to exposures in the 1980s or early 1990s. Therefore, from the point of view of the investigation of a possible cancer cluster, exposures of interest were primarily those that occurred in the 1980s and early 1990s, rather than current exposures. However, where exposure patterns had not changed much, current exposures could provide a good insight into these past exposures. In addition, if there are still significant exposures, or potential exposures, to carcinogens, it is important to know this so that the Gallery staff members and management can be informed and institute the necessary controls.

Stage 1 of the project attempted to identify all the carcinogens to which Gallery staff members had been, or might have been exposed, and the exposure circumstances. This investigation did not focus on non-carcinogenic exposures, as this was not within the terms of reference of the project, apart from specific questions on aspects of occupational health and safety that were asked by staff in 2005 and which were included in the overall project requirements. Stage 2 involved an epidemiological assessment of the occurrence of cancer in past and current Gallery employees.

2.2 INFORMATION FROM STAFF

The National Gallery of Australia first opened to the general public at the end of 1982. The Gallery Building was occupied by staff from late 1981. As with any such workforce, there has been considerable turnover of staff since then. Many of the staff members who could provide information on exposures and work practices were no longer working at the Gallery, and most of these were not available for interview. Some current staff members had been working at the Gallery since it opened or commenced work at the Gallery soon after this. These staff members were able to provide direct information on past exposures. Some other staff members who were first employed more recently were able to provide information on current exposures and on how exposures might have changed in recent years.

Staff members were informed about the project in an information seminar (held twice on the same day) by Dr Driscoll and Mr Foster on 23rd August 2006. A web page devoted to the study was created on the Gallery web site and provided information about the study, such as the slide presentation from the information seminar, the Terms of Reference for the project, and the minutes from the Steering Committee meetings. Staff members were encouraged several times via email from management to provide any information that they felt was relevant. Via the web site, and through articles in the press, ex-workers were also encouraged to provide information.

Information was collected during trips to Canberra in September, October, November, and December 2006, and January and March 2007. In total, discussions were held with approximately 25 current staff members and approximately six past staff members. A small amount of information was also provided via email from many individual current or former staff members.

Virtually all the information from current and former staff was obtained through face-to-face interviews with individual staff, and through visiting different work areas and discussing past and current exposures and work practices with the relevant current staff. The face-to-face interviews were usually attended by both Dr Driscoll and Mr Foster, although some interviews involved only one of the project team members. These interviews were held in confidence, without any of the steering committee members or members of management being in attendance. None of the information provided by individuals is presented in this report in a manner that would allow the individual to be identified (unless this was deemed important and the individual stated that identification was acceptable to them). The information was primarily provided orally, but in some cases individuals provided copies of relevant documentation.

2.3 INFORMATION FROM SITE VISITS

Site inspections were held during visits to the Gallery in September, October and November 2006 and February 2007. These inspections involved walking through the relevant areas, both inside and outside the Gallery building, and holding discussions with staff working in these areas. Not all work areas were visited, but all work areas that were considered to potentially have, or have had, exposure to hazardous substances were formally inspected. These included Conservation, the Workshop, the Security control room, Chemical stores, air-conditioning plant areas, Building services, the HVAC office, the Security tea room, the Loading and receiving dock, Art storage, Registration, Photography and public galleries.

2.4 INFORMATION FROM INVESTIGATION REPORTS

Several major investigations into aspects of occupational health and safety at the Gallery have been conducted over many years and have resulted in major reports. These were made available to the study team. In addition, many smaller investigations or measurements have resulted in minor reports. These were also made available to the study team, along with other potentially relevant documentation, such as sick leave reports and ad-hoc incident reports. A list of all potentially relevant documents seen by the study team is shown in Appendix 1.

The documentation was read in detail or skimmed, depending on its perceived importance, looking for information relevant to the investigation of the cancer cluster. Many of the reports provided information on important occupational health and safety issues, but issues that were not relevant to the focus of the project. Such information was not used for the current project, except where it was relevant to the occupational health and safety questions asked by staff in 2005.

2.5 CLASSIFICATION OF CARCINOGENICITY

There are a number of different systems used for classifying substances in terms of their ability to increase the risk of developing cancer (also know as their 'carcinogenicity'). The primary system is the one run by the International Agency for Research on Cancer (IARC). Australia has its own system, developed by the National Occupational Health and Safety Commission (NOHSC), and which is based on the classification system used by the Commission of the European Communities.

The information presented in this report is based on the IARC classification, but the NOHSC classification is included also. Note that where a substance is considered to be not carcinogenic, or no determination has been made regarding carcinogenicity, the NOHSC system does not apply a classification, whereas the IARC system does. Also, the NOHSC system does not classify physical exposures (such as radiation), whereas the IARC system does. The IARC and NOHSC classification systems are listed in Appendix 2. The IARC and NOHSC classifications, and the NOHSC exposure standards, for the main exposures considered in the report are provided in Appendix 3.

2.6 ANALYSIS OF CANCER RATES

Employment data were provided for all current and past employees by the Human Resources section of the Gallery. This information was current to 30/9/2007. Information on early employees had to be obtained by matching names to other information contained on microfiche. The required information to determine the at-risk period (date of first employment) was missing for some past employees. These people had to be excluded from the analysis because their at-risk period could not be calculated.

Standardised incidence ratios were calculated using Australian cancer incidence rates. The calculation was undertaken for all cancers combined, separately for both genders and combined, as well as for breast cancer (in women), prostate cancer (in men) and colo-rectal (bowel) cancer and lung cancer (in persons). Some separate analyses were also conducted for security officers. Confidence intervals were calculated assuming a Poisson distribution.

The approach used to determine eligibility, identify cases and conduct the analysis is described in detail in Chapter 9. In brief, the study period was from 1/1/1982 to 31/12/2004 inclusive. Any person who worked for at least one day on or between these dates was eligible to be included in the study. Cases were identified using the National Cancer Statistics Clearing House (NCSCH) of the Australian Institute of Health and Welfare (AIHW). This covered all incident (new) cancer cases (except non-melanotic skin cancers) in Australia that occurred between 1/1/1982 and 31/12/2004 inclusive. Any cancer that was diagnosed on or between these dates was accepted for inclusion and any person who developed such a cancer was accepted as a case, subject to other criteria. These criteria were that the person had to have worked at the Gallery at some time during the study period, and the cancer had to have been diagnosed after they had worked at least one day during the study period.

2.7 ETHICS CLEARANCE AND CONSENT

This study was approved by the Human Research Ethics Committee of the University of Sydney, by the Human Research Ethics Committees of each of the State and Territory Cancer Registries, and by the Human Research Ethics Committee of the AIHW.

3. EXPOSURE TO DEFINITE CARCINOGENS

3.1 INTRODUCTION

Exposures classified by IARC as being "definitely carcinogenic to humans" (IARC Group 1) are substances or exposure circumstances where there is strong human evidence, usually supported by animal evidence, of an association between exposure and increased risk of one or more cancers. This chapter considers IARC Group 1 carcinogens to which Gallery staff members have, or potentially have, been exposed at some time since the main Gallery building opened. A list of the relevant carcinogens is shown in Table 1.

Table 1 IARC Group 1 carcinogens to which Gallery staff members have, or potentially have, been exposed.

Exposure
Asbestos
Benzene
Cadmium
Environmental tobacco smoke
Ethylene oxide
Formaldehyde
Radium
Wood dust
X-rays

3.2 ASBESTOS

Description

Asbestos is a naturally occurring fibrous mineral that was used widely as a building material and for insulation.

Health effects

Asbestos is classified as a definite human carcinogen (IARC Group 1)[6]. Lung cancer and mesothelioma are the cancers most strongly associated with exposure to asbestos. Asbestos is classified as a Category 1 carcinogen by NOHSC[7].

Past exposures

Asbestos was used in the Gallery building in the form of asbestos cement sheeting ('Fibro'), as well as in insulation of fire doors and pipe lagging. As far as is known, asbestos was not used to line air conditioning ducts. Asbestos was also used in roofing in the 1980s in the form of "Nuralite", an asbestos-containing building sheet material. This roofing was replaced between June 1990 and February 1992. Prior to replacement of the roof, repair work was undertaken at various times. An opinion was obtained in 1985 that stated that, because the asbestos in Nuralite roofing is bound in an asbestos matrix, exposure to asbestos was very likely to be negligible even if significant building or removal work were to be done with the material[8]. This was based on theoretical considerations and measurements made previously while workmen installed the material on a building. Nevertheless, some monitoring was done prior to and during the removal of the Nuralite. The monitoring prior to the removal (conducted in June 1990) did not reveal the presence of any airborne asbestos fibres. The results of monitoring conducted during the removal are not known. However, a memo from May 1990 states that "It was confirmed that the asbestos was being removed by a registered firm and all works would be conducted under the eye of the Hazardous Materials sections of the ACS [Australian Construction Services], and that monitoring would be continuous." (memo from Kevin Munn, dated 15 May 1990). This suggests that exposures are likely to have been properly controlled.

Asbestos removal was undertaken by contractors in the sub-floor area under Gallery 9 in September 2006. This removal was cleared as complete at the time, based on visual inspection and airborne fibre monitoring.

There have been a number of documented incidents and concerns about asbestos that were investigated prior to this investigation and during which samples were taken for analysis. Insulation material from air handling units was analysed in 2003 but found to be Synthetic Mineral Fibre (SMF) and cellulose (plant material). No asbestos was detected. Air monitoring was conducted during the contractor removal of asbestos rope

lagging on water pipes in a boiler room. The air monitoring results were below the Minimum Practical Detection Limit of 0.01 fibres per ml.

Concern was raised about an incident that occurred in the fitter's workshop on 13 July 2000. A contractor cut into a fire panel of asbestos cement, using a jigsaw, while installing an extraction fan. One workshop employee witnessed the incident. The area was sealed and cleaned up by a contractor on 15th July. The sheeting material was found to contain chrysotile and amosite asbestos. Air monitoring was carried out on 13th and 15th July 2000 and results for fibres were below the detection limit. Some cleaning was done by an NGA employee on 15th July 2000 using a vacuum cleaner with a HEPA filter. The bag was given to the removal contractor for disposal. A follow up survey of asbestos in the area found two fibres on a window sill in the store room adjoining the fitter's workshop. Subsequent air monitoring and dust sampling found no further asbestos fibres in the area.

Current exposures

A very detailed asbestos audit was conducted in January 2007 as part of the development of an asbestos management plan[9]. This plan documents all the known asbestos in and around the Gallery building and documents the procedures that need to be followed in terms of performing work with, or removing, asbestos containing materials. Asbestos-containing material remains in a number of areas, but not in areas to which the public or workers would be expected to come into contact. Where asbestos-containing material potentially could come into contact with workers or the public, such as with the fire doors that contain asbestos, the asbestos is encapsulated and does not pose a risk if left undisturbed.

Conclusions

There is no evidence that Gallery staff members would have been exposed in the past to asbestos above the exposure standard limits. Exposure of Gallery staff members to asbestos should not have resulted in a meaningful increased risk of developing cancer, and there should be no on-going exposure to asbestos above the background rate.

Recommendations

Follow the recommendations of the January 2007 asbestos management plan, including referring to the relevant procedures when new or maintenance work is being undertaken and labelling asbestos-containing material.

- *Gallery officers subsequently informed the authors that they had completed labelling of asbestos in the building and would continue to follow the Asbestos Management Plan.*

3.3 BENZENE

Description

Benzene is an organic solvent with a wide range of industrial uses.

Health effects

Benzene is classified as a definite human carcinogen (IARC Group 1)[10]. Leukaemia is the cancer most strongly associated with exposure to benzene. Benzene is classified as a Category 1 carcinogen by NOHSC[7].

Past exposures

Small amounts of benzene were used in the Conservation Department at the Fyshwick site for six to eight years prior to the opening of the present Gallery building. It appears that the chemical was used in identification tests under the microscope and for ageing treatments in small amounts. Exposure would have been minimal and involved only the scientific officer employed at the time.

There was a small amount of benzene in the sump oil used for the "20:50" exhibit (see Section 7.11). The level of benzene vapour in the room is estimated to have been very low and well below the current Exposure Standard of 1 ppm for an 8-hour exposure. However, the maximum exposure time of staff in the area on any given day is not certain.

Current exposures

Benzene is no longer used by, or at, the Gallery.

Conclusions

Benzene exposures would have been very low, intermittent and well below the current exposure standard of 1 ppm, TWA 8-hour average. Exposure of Gallery staff members to benzene should not have resulted in a meaningful increased risk of developing cancer.

3.4 CADMIUM

Description

Cadmium and cadmium compounds have a variety of uses, including pigments.

Health effects

Cadmium is classified as a definite human carcinogen (IARC Group 1)[11]. Lung cancer and (possibly) prostate cancer are the cancers most strongly associated with exposure to cadmium. Cadmium is classified as a Category 2 carcinogen by NOHSC[7].

Past exposures

Cadmium (as a sulphide) is a component of a yellow, orange and red pigments used by the Conservation Department. The procedures have not changed over the years.

Current exposures

Exposures are only ever likely to have been very low because the amounts used at any one time are very small. Pigments and powders are currently stored in small glass containers in a shelf near the work area. Powdered pigments are mixed with varnish and solvents. The pigments are mixed in small dip dishes and applied to the painting. Blending is done with the brushes or palette knives so skin contact may be possible. Dust inhalation is unlikely during mixing and application.

Pigments are decanted from larger pots into the small jars when necessary. This is done in a fume cupboard with a dust mask. The way the small containers were arranged on the shelf at the time of inspection made it difficult for staff members to read labels. There was also small risk of knocking one or more of the containers onto the floor with the current set up. This has since been rectified by arranging glass containers on the shelf such that they cannot be knocked over and the labels are more easily read, as recommended at the time of the Stage One report.

Storage appeared appropriate in most instances, but a large container of cadmium pigment was found stored in a cupboard near the Paper Section. The container was not properly labelled according to NOHSC guidelines for hazardous substances[12].

These potential exposure circumstances are different to most of those resulting in the IARC classification.

Conclusions

Exposure of Conservation staff members to cadmium compounds should not have resulted in a meaningful increased risk of developing cancer. However, care must be taken when decanting cadmium pigment to avoid dust generation and exposure, and the storage and labelling of cadmium and other pigments needed to be improved. This has since occurred.

Recommendations

Arrange glass containers on the shelf such that they cannot be knocked over and the labels are more easily read.

- *This has since been addressed by the Gallery, with appropriate access arrangements and labelling according to proper specifications.*

Continue using a fume cupboard when decanting bulk pigment powders.

- *Gallery officers have since confirmed that they have developed work procedures to ensure this recommendation is followed.*

3.5 ENVIRONMENTAL TOBACCO SMOKE

Description

Environmental tobacco smoke is tobacco smoke that arises as a result of someone else smoking. It is either exhaled smoke or smoke arising from the smouldering cigarette (or pipe).

Health effects

Environmental tobacco smoke is classified as a definite human carcinogen (IARC Group 1)[13]. Lung cancer is the cancer most strongly associated with exposure to environmental tobacco smoke. Environmental tobacco smoke is not classified in terms of carcinogenicity by NOHSC.

Past exposures

Smoking was permitted in the non-art areas of the Gallery (places such as the members' lounge, the restaurant and the curatorial offices) up to some time between 1989 (when it is known to have still been permitted) and 1992 (when it is known to have been prohibited). The level of exposure in these areas is not known. Smoking in office areas was prohibited from 1988, when the Australian Public Service adopted a smoke-free environment. Smoking has always been prohibited in the areas of the Gallery containing the collection. There may have been some exposure to environmental tobacco smoke outside the building, but it is unlikely that these exposures would have been at a level that would have caused a meaningful increase in the risk of developing cancer as a result of the exposure.

Current exposures

The potential for exposure to environmental tobacco smoke has greatly decreased since the late 1980s / early 1990s. Since then, the only source of potential exposure has been in the Gallery grounds if members of the public or Gallery staff members were smoking, and this exposure potential probably hasn't changed in recent years, with the proviso that exposures may have decreased due to a decreasing proportion of the general population smoking and from actions taken by the Gallery to restrict areas where smoking is permitted.

Conclusions

Exposure of Gallery staff members to environmental tobacco smoke is not likely to have resulted in a meaningful increased risk of developing cancer, but there is a lack of information on the extent and levels of exposure until smoking was banned from all areas of the Gallery some time between 1989 and 1992.

3.6 ETHYLENE OXIDE

Description

Ethylene oxide is a gas used for sterilising and fumigation.

Health effects

Ethylene oxide is classified as a definite human carcinogen (IARC Group 1)[14]. Leukaemia is the cancer most strongly associated with exposure to ethylene oxide. Ethylene oxide is classified as a Category 2 carcinogen by NOHSC[7].

Past exposures

Ethylene oxide was used by the Conservation Department to fumigate costumes until the late 1980's. Fumigation was done off-site by contractors. The room was vented for 12 hours before staff entered to remove the fumigated objects. Under these circumstances exposure to ethylene oxide would have been very low.

Current exposures

Ethylene oxide has not been used since the 1980s. Fumigation is now done by freezing or oxygen replacement treatment with nitrogen.

Conclusions

Gallery staff members' exposure to ethylene oxide in the past was negligible. Exposure of Gallery staff members to ethylene oxide should not have resulted in a meaningful increased risk of developing cancer.

3.7 FORMALDEHYDE

Description

Formaldehyde has a wide variety of uses. These include the production of resins, which are in turn used as binders in particle board and similar products, such as medium density fibreboard (MDF).

Health effects

Formaldehyde is classified as a definite human carcinogen (IARC Group 1)[15]. Nasopharyngeal cancer is the cancer most strongly associated with exposure to formaldehyde, although there is reasonably strong evidence also for an association with leukaemia. Formaldehyde is classified as a Category 1 carcinogen by NOHSC[7].

Past exposures

Medium density fibreboard was, and still is, used extensively in the construction of exhibits. Carpenters were potentially exposed to dust when working with this material both in the workshop and exhibition areas. Carpenters and other staff, including security staff, would have been exposed to dust when power tools were used on the MDF. Security employees were required to guard the construction zones. One workshop carpenter reported experiencing skin rashes when he worked with MDF.

Outdoor and indoor formaldehyde levels were compared in measurements taken in 1995. Indoor levels were found to be slightly higher than those outdoors, but all levels were below NHMRC guidelines and not expected to cause detrimental effects on staff or visitors.

The level of aldehyde exposure was assessed in January 2003 in the Exhibition Gallery. This followed complaints of tiredness experienced by security guards. Formaldehyde was the only aldehyde detected, and this was at a level of 0.015 ppm, which is well below the NOHSC Exposure Standard of 1 ppm for an 8-hour exposure[7]. However, measured levels were above the level at which some people have reported irritant effects such as eye irritation, nausea and headaches. The report recommended that all MDF be adequately sealed.

Formaldehyde has been measured in the kitchen, loading dock, plant room, workshop, Conservation Department, restaurant, art storage areas and level 8 office areas. All results were below exposure limits and National Health and Medical Research Council (NHMRC) guidelines.

Current exposures

Workshop carpenters still work with MDF. The workshop is now equipped with a dust extraction system. This appears to have been installed in the mid 1990s. Workers also wear P1 disposable dust masks (3M 8710), which are appropriate for the job.

The exhibition areas are isolated / restricted access areas during construction of new exhibits and contractors wear masks. These areas have restricted access for all except construction contractors. Security staff members do enter these areas, up to four times per day, but not usually when the work is underway. It appears that once per day, for less than five minutes, a security guard may enter construction areas when work is in progress. Most cutting of MDF is done off site. Cutting of MDF that is required to be done in the Gallery building is conducted inside an area sealed inside a plastic "tent", with exhaust ventilation via enclosed extractions systems connected to the saw and/or a separate extraction system connected to an industrial vacuum cleaner.

Conclusions

Formaldehyde levels were found to be higher inside the Gallery than outside. Measured levels were found to be below the NOHSC Exposure Standard and NHMRC Guidelines. One survey advised that despite the measured levels being below recommended levels, they were high enough to have caused irritant effects in some people. Recommendations were given for reducing exposure levels to a minimum. Exposure of Gallery staff members to formaldehyde should not have resulted in a meaningful increased risk of developing cancer.

Recommendations

Ensure that MDF panels in exhibits are sealed. If irritation occurs, a respirator designed for formaldehyde exposure should be used. Advice on this should be sought from respirator suppliers. Dust particulate masks, Class P1, should adequately reduce exposure to dust from MDF but not necessarily to formaldehyde vapour. These masks will reduce exposure to formaldehyde which is adsorbed onto dust particles.

- *Gallery officers subsequently confirmed that these recommendations were being followed.*

Security guards entering construction areas when airborne MDF dust may be present (e.g. during sawing operations) should also wear an appropriate dust particulate mask whilst in the construction area.

- *Gallery officers subsequently confirmed that these recommendations were being followed.*

3.8 RADIUM

Description

Radium is a radioactive element that, amongst other uses, is sometimes used in decorative paint.

Health effects

Radium is classified as a definite human carcinogen (IARC Group 1)[16]. A wide variety of cancers could potentially be caused by exposure to radium. Radium is not classified in terms of carcinogenicity by NOHSC[7], although the associated ionising radiation is clearly carcinogenic[17].

Past exposures

One past exhibit - "Costume for Constellation in the ballet *Ode*" – was thought to have possibly used paints containing radium to give a fluorescent appearance. However, available information on this exhibit states that the paint used was zinc and barium-based, and no radium was detected in it. The costume has only been exhibited once, in 1988/1989. According to Conservation Department staff, radiation levels were measured at the time of installation and found to be below the relevant exposure standards. There is a standard working procedure used when dealing with the costume (the procedure includes the use of gloves, goggle and mask). No other exhibit items are known to have contained radium-based paints, although it is possible this might occur without Gallery staff members being aware.

Current exposures

It is possible that paints containing radium could be used for future exhibits, although there are no plans for this at present. If there are exhibits of concern, formal radiation testing by an accredited tester can be arranged.

Conclusions

Radium paints are used very rarely and exposures are very likely to have always been well below exposure standards. No exposure of Gallery staff members to radium is known to have occurred, but any such exposure that did occur should not have resulted in a meaningful increased risk of developing cancer.

3.9 WOOD DUST (OTHER THAN MDF)

Description

A wide variety of occupational circumstances involve exposure to wood dust. In the context of the Gallery, these particularly include carpentry.

Health effects

Wood dust is classified as a definite human carcinogen (IARC Group 1)[18]. The evidence is strongest for hard wood and for mixtures of hard wood and soft wood, with equivocal evidence for soft woods alone. Adenocarcinoma of the nasal cavities and para-nasal sinuses is the cancer type most strongly associated with dust, but there is some evidence of an increased risk of cancer of the nasopharynx[19, 20]. Wood dust is not classified in terms of carcinogenicity by NOHSC[7].

Past exposures

Exposure to hardwood timber dust could have occurred when routing, cutting or sanding, etc. It is not clear the extent to which dust masks were worn in the past. Hardwoods (mainly Blackwood and Ashwood) were used, but not to any great extent. Softwoods used included Western Red Cedar.

Current exposures

Hardwoods are still occasionally used, but only to a minor extent compared with MDF. The workshop is now fitted with improved exhaust ventilation. Masks (P1 disposable dust masks, which are appropriate for the job) are worn when emptying dust collection bags from the exhaust system.

Conclusions

Exposure of Gallery staff members to wood dust should not have resulted in a meaningful increased risk of developing cancer.

Recommendations

Continue to wear P1 dust respirator when likely to be exposed to wood dust.

- *Gallery officers subsequently informed the authors that this practice will continue for staff and contractors.*

3.10 X-RAYS

Description

X-rays are a form of ionising radiation. Exposure to x-rays occurs in several occupational contexts, including in the use of x-ray machines.

Health effects

X-rays are classified as definite human carcinogens (IARC Group 1)[21]. A variety of cancers, particularly leukaemia, thyroid cancer and breast cancer, are strongly associated with exposure to x-rays. X-rays are not classified in terms of carcinogenicity by NOHSC, although the associated ionising radiation is clearly carcinogenic[17].

Past exposures

Paintings are x-rayed on rare occasions (once or twice per year) in a special room in the Conservation Department. The operating controls are outside the room and the operator should not be exposed at that position. There is only one trained operator and this person has been the only operator of the machine since the late 1980s. The room is regularly checked for leaks. A very slight leak at the door was found when the room was first tested (in 1982 or 1983), but there was no suggestion of significant exposure to any personnel. The leak was fixed and no leaks have been detected since. A radiation dosimeter was not used by operators of the x-ray machine in the early years of Gallery operation, but in more recent years personal monitoring has occurred. Since the x-ray machine is used rarely, dosimeters are purchased for a specific task and then disposed of.

Current exposures

The x-ray room is only used occasionally. There is currently only one Gallery employee who is a fully trained radiation safety officer. The single operator is adequately protected against significant exposure to x-rays. The x-ray machine and its use is licenced by the Australian Radiation Protection and Nuclear Safety Agency and meets all relevant requirements, including quarterly reports and annual inspections. There is a specific standard work procedure covering operation of the x-ray equipment.

Conclusions

Gallery staff members have never been significantly exposed to x-rays. Exposure of Gallery staff members to x-rays should not have resulted in a meaningful increased risk of developing cancer.

4. EXPOSURE TO PROBABLE CARCINOGENS

4.1 INTRODUCTION

Exposures classified by IARC as being "probably carcinogenic to humans" (IARC Group 2A) are substances or exposure circumstances where there is reasonable human evidence of an association between exposure and increased risk of one or more cancers, but for which the evidence is not strong enough to be able to categorically state that such a link exists. It is prudent to assume that such exposures are likely to be carcinogenic and to minimise exposure levels as much as possible. This chapter considers IARC Group 2A carcinogens to which Gallery staff members have, or potentially have, been exposed at some time since the main Gallery building opened. A list of the relevant carcinogens is shown in Table 2.

Table 2 IARC Group 2A carcinogens to which Gallery staff members have, or potentially have, been exposed.

Exposure
Diesel fumes
Epichlorohydrin
Polycyclic aromatic hydrocarbons
Tetrachloroethylene

4.2 DIESEL FUMES

Description

Diesel exhaust fumes enter the building when delivery trucks reverse into the two loading docks. Diesel exhaust consists of small particulate matter, carbon monoxide, carbon dioxide and oxides of nitrogen, plus other substances. Organic compound molecules, including polyaromatic hydrocarbons, are adsorbed onto the particulate.

Health effects

Diesel engine exhaust is classified as being probably carcinogenic to humans (IARC Group 2A)[22]. Lung cancer and bladder cancer are the two cancers most strongly associated with exposure to diesel engine exhaust. Diesel fumes are not classified in terms of carcinogenicity by NOHSC.

Past exposures

There have been a few notable instances of idling vehicles in the delivery area exposing Gallery staff members to fumes. The contaminated air has spread into the art storage receiving and storage areas, as well as into the security control room and adjoining ground floor areas.

Current exposures

Vehicle drivers are advised (via large signs) to stop their engines after they stop their vehicle for loading or unloading. Despite the signs there are still occasions where vehicles are left idling in the loading dock. Exposures are usually intermittent and depend on the frequency of truck deliveries. Exposures can be fairly constant when many trucks are arriving and leaving during exhibit change over. Fumes are drawn into the art storage area when the large sliding door at the rear of the loading dock area is open.

Although odours are strong, measurements have shown that levels of carbon monoxide are well below the TWA Standard of 30 ppm for 8 hours (Robson Laboratories 2006). Consequently, exposure to diesel particulate is also expected to be low. Formal measurements of exposure to diesel particulate had not been undertaken at the time of completion of the Stage One report in March 2007. This monitoring was subsequently undertaken in April and June of 2007. Two sets of measurements were undertaken because the first one was thought to have been conducted at a period of low truck activity. The second set of measurements was undertaken during a day when it was likely there would be high truck activity in the loading bay. Both sets of measurements identified minimal levels of diesel particulate (as measured by elemental carbon). Higher levels can be anticipated if trucks are allowed to have their motors idling while they are in the loading bay. Based on reports from staff, the levels of exposure at such times may be high enough to cause unpleasant odours and nasal irritation, but they are very unlikely to ever be at a level that might cause lasting health effects.)

Conclusions

The diesel fumes create strong and unpleasant odours, but testing and observation strongly suggest the fumes would not reach a level where they would be expected to have lasting health effects. The strong odours have been reported to cause nausea in some staff and diesel fumes are considered to be probably carcinogenic. For both these reasons exposures should be controlled as much as possible.

Recommendations

Formal measurements should be made of current exposures to diesel particulate.

- *Gallery officers subsequently arranged for these measurements to be taken, as mentioned earlier in this section.*

The loading dock should be designed so that it is isolated from areas occupied by staff once the new extension and renovation of the building are completed. Alternatively, exhaust ventilation could be fitted to the loading dock to capture the exhaust fumes. Some form of exhaust ventilation appears to be warranted as an interim measure while the new extension is being planned and built. The practicalities of installing such ventilation as a short-term measure in the current building should be investigated by Gallery officers. In addition, it would be appropriate to formally inform (in writing) all delivery drivers and contractors of the importance of turning off their truck engines when stopped in the loading dock. This requirement should be rigorously enforced by Gallery officers responsible for receiving or sending goods via the delivery and loading docks.

- *Gallery officers agreed to address this issue, and subsequently provided the following information: "The new extensions will include separate art and general goods loading docks. The new arts loading dock has been completed and commissioned. The dock is separated from the rest of the building by a sealed door. The dock has a dedicated exhaust ventilation system. The new general goods dock will have similar arrangements.".*

- *Gallery officer subsequently informed the authors that they had instigated a control measure where diesel fumes exposure is limited by ensuring all engines are turned off while vehicles are in the loading dock. The Gallery Engineering Consultant is evaluating possible short-term ventilation options for consideration. Gallery officers subsequently provided further information: "A cost proposal was received, and because of the proposed changes to the loading dock it was not considered to be cost effective to make interim changes. The Gallery wrote to all its suppliers requesting they advise their drivers to switch off their engines while in the loading dock. Signs advising this were also installed. Security staff were requested to be vigilant in ensuring that all drivers observed this requirement.".*

4.3 EPICHLOROHYDRIN

Description

Epichlorohydrin is a catalyst used in epoxy glues.

Health effects

Epichlorohydrin is classified as probably being carcinogenic to humans (IARC Group 2A)[23]. Lung cancer is the main cancer identified as possibly being related to exposure to epichlorohydrin. Epichlorohydrin is classified as a Category 2 carcinogen by NOHSC[7].

Past exposures

Epichlorohydrin has been used in the Objects area of the Conservation Department for the past 10 years, where small amounts have been used as a constituent in epoxy resins and glues. A fume hood and/or exhaust ventilation are routinely used during potential exposure. Exposure levels are likely to have been very low.

Current exposures

Use and exposure circumstances have not changed.

Conclusions

Exposure to epichlorohydrin is likely to have been very low. Exposure of Gallery staff members to epichlorohydrin should not have resulted in a meaningful increased risk of developing cancer.

4.4 POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

Description

Polycyclic aromatic hydrocarbons (PAHs) occur throughout the environment. They result from the incomplete burning of organic material such as fossil fuels, but exposure can occur in a wide variety of circumstances.

Health effects

Polycyclic aromatic hydrocarbons usually occur as a mixture of a number of different chemical compounds. Some of these are carcinogenic, some are not, and many have not been studied enough to allow a firm conclusion about carcinogenicity to be made. Their IARC classification range from definite human carcinogen (IARC Group 1) to not being classifiable as to their carcinogenicity to humans (IARC Group 3)[24]. None of the Group 1 exposure circumstances are likely at the Gallery, so PAHs have been included in the chapter covering probable carcinogens. Cancer of the lung, bladder and skin have all been associated with PAH exposure in humans[25]. Polycyclic aromatic hydrocarbons as a group are not classified in terms of carcinogenicity by NOHSC.

Past exposures

Polycyclic aromatic hydrocarbons and other organic compounds are adsorbed onto carbon particles which make up diesel particulates. It follows that there is some exposure to PAHs to staff in the loading dock area. Exposure levels are estimated to be very low compared to road traffic exposures. PAHs also made up a small part of the oil used in the 20:50 exhibition. The airborne vapour level of PAHs is estimated to have been negligible. No staff members were exposed for significant lengths of time to volatile hydrocarbons in the exhibit room. Exhaust ventilation would have also reduced exposure levels (see Section 7.11 for details)

Current exposures

Staff members are currently still intermittently exposed to PAHs in diesel fume in the loading dock and surrounding areas.

Conclusions

Exposure to PAHs has probably been negligible, except through exposure to diesel fumes.

Recommendations

Refer to recommendations for diesel fume control.

4.5 TETRACHLOROETHYLENE

Description

Tetrachloroethylene (also known as perchlorethylene) is an organic solvent sometimes used in dry-cleaning fluid.

Health effects

Tetrachloroethylene is classified as probably being carcinogenic to humans (IARC Group 2A)[26]. Non-Hodgkin's lymphoma and oesophageal and cervical cancer are the main cancers identified as possibly being related to exposure to tetrachloroethylene exposure. Tetrachloroethylene is classified as a Category 3 carcinogen by NOHSC[7].

Past exposures

Tetrachloroethylene was used for spot treatments of garments in the Conservation Department. In the early years of the Gallery's operation, garments were washed with solvents such as xylene, toluene and 1,1,1-trichloromethane in a specially-designed bath fitted with a canopy exhaust hood. Spot treatments were done using a range of solvents, including tetrachloroethylene. If these were found to be effective, a more extensive cleaning of the garment would occur using a fume cupboard. Nitrile gloves were used and staff wore lab coats. When working with larger amounts of solvent, half-face organic vapour respirators would usually be worn. It appears that on rare occasions there may have been some minor skin exposure.

Tetrachloroethylene has been used since the beginning of 1997 in black and white photograph development. The development was undertaken in a dark room with appropriate extraction ventilation. It appears that appropriate personal protective equipment (goggles and gloves) was used most of the time, although there is some suggestion of working without gloves occasionally. Few staff members were potentially exposed.

Current exposures

Costumes and garments are now dry cleaned off site occasionally. Gallery staff members are estimated to spend about one hour, five or six times per year, at the dry cleaners. Staff said that they could smell the odour of dry cleaning solvent when transporting the cleaned garments in the rear car seat back to the Gallery. Tetrachloroethylene is still used occasionally for spot treatments, with staff using the same control measures as they have previously.

Tetrachloroethylene is still used in black and white photograph development in the photography section, but the use of personal protection equipment appears appropriate and there are very few staff members with potential exposure.

Conclusions

The staff members' exposure to tetrachloroethylene vapours is expected to be well below the TWA exposure standard of 50 ppm and the short term exposure limit (15-minute average) of 150 ppm for tetrachloroethylene. Exposure of Gallery staff members to tetrachloroethylene should not have resulted in a meaningful increased risk of developing cancer.

5. EXPOSURE TO POSSIBLE CARCINOGENS

5.1 INTRODUCTION

Exposures classified by IARC as being "possibly carcinogenic to humans" (IARC Group 2B) are substances or exposure circumstances where there is weak human evidence of an association between exposure and increased risk of one or more cancers. As with Group 2A exposures, it is prudent to minimise exposure as much as possible. This chapter considers IARC Group 2B carcinogens to which Gallery staff members have, or potentially have, been exposed at some time since the main Gallery building opened. A list of the relevant carcinogens is shown in Table 3.

Table 3 IARC Group 2B carcinogens to which Gallery staff members have, or potentially have, been exposed.

Exposure
Carbon black
Carbon tetrachloride
Cobalt
Dichloromethane
Dichlorvos
Extremely low-frequency electro-magnetic fields
Magenta
Potassium bromate
Synthetic mineral fibres
Welding fumes

5.2 CARBON BLACK

Description

Carbon black is a carbon powder used in the manufacture of many products, including inks, paints and pigments.

Health effects

Carbon black is classified as possibly being carcinogenic to humans (IARC Group 2B)[27]. Lung cancer, oesophageal cancer, kidney cancer and bladder cancer are the main cancers identified as possibly being related to exposure to carbon black. Carbon black is not classified in terms of carcinogenicity by NOHSC[7].

Past exposures

Carbon black is a component of inks used by the Conservation Department. It is also used in pigments, with the dry form being mixed with a binder. The procedures have not changed over the years.

Current exposures

See the comments made for cadmium – Section 3.4.

Conclusions

See the comments made for cadmium – Section 3.4.

Recommendations

See the comments made for cadmium – Section 3.4.

5.3 CARBON TETRACHLORIDE

Description

Carbon tetrachloride is an organic solvent that was commonly used in dry cleaning.

Health effects

Carbon tetrachloride is classified as possibly being carcinogenic to humans (IARC Group 2B)[23]. Non-Hodgkin lymphoma is the main cancer identified as possibly being related to exposure to carbon tetrachloride. Carbon tetrachloride is classified as a Category 2 carcinogen by NOHSC[7].

Past exposures

Carbon tetrachloride was used on a small number of occasions in the Conservation Department for spot cleaning of material. Exposures are likely to have been very low.

Current exposures

Carbon tetrachloride is no longer used in the Conservation Department.

Conclusions

Exposures to carbon tetrachloride are likely to have been very low. Exposure of Gallery staff members to carbon tetrachloride should not have resulted in a meaningful increased risk of developing cancer.

5.4 COBALT

Description

Cobalt is used in blue, yellow and green pigments.

Health effects

Cobalt is classified as possibly being carcinogenic to humans (IARC Group 2B)[28], but there is no human evidence relevant to exposure to cobalt in pigments or dyes. Cobalt in dyes is not classified in terms of carcinogenicity by NOHSC[7].

Past exposures

Cobalt (in compound form) is a component of a pigments used by the Conservation Department. The procedures have not changed over the years.

Current exposures

See the comments made for cadmium – Section 3.4.

Conclusions

See the comments made for cadmium – Section 3.4.

Recommendations

See the comments made for cadmium – Section 3.4.

5.5 DICHLOROMETHANE

Description

Dichloromethane (methylene chloride) is an organic solvent that can be used in degreasing.

Health effects

Dichloromethane is classified as possibly being carcinogenic to humans (IARC Group 2B)[23]. A wide range of cancer types have been weakly linked to exposure to dichloromethane. Dichloromethane is classified as a Category 3 carcinogen by NOHSC[7].

Past exposures

Small amounts of dichloromethane appear to have been used in the Conservation Department at some stage in the past for spot treatments, with use of appropriate gloves. It is likely that exposures were very low.

Current exposures

Dichloromethane is no longer used in the Conservation Department.

Conclusions

Exposures to dichloromethane are likely to have been very low. Exposure of Gallery staff members to dichloromethane should not have resulted in a meaningful increased risk of developing cancer.

5.6 DICHLORVOS

Description

Dichlorvos is an insecticide.

Health effects

Dichlorvos is classified as possibly being carcinogenic to humans (IARC Group 2B)[29]. Leukaemia is the only human cancer identified as possibly being related to exposure to dichlorvos. Dichlorvos is not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

In 1981, the Flick Company used dichlorvos and azamethiphos in the Gallery. Ficam, which is a carbamate insecticide, was also used but is not carcinogenic. Other spraying was done by contractors. Pestigas (pyrethrin) was used in a warehouse at Hume in the past, with the pesticide released as an aerosol. Security staff members were given a respirator if they had to enter the area soon after spraying. Dersban was trialled outside the Gallery building. It is an organophosphate pesticide and not thought to be carcinogenic.

Current exposures

The perimeters of each room in the Gallery (including galleries, art storage areas, kitchens and the warehouse) are sprayed with a pyrethrum based pesticide every three months. Pyrethrum is not carcinogenic.

Conclusions

Pesticide spaying is only carried out when nearly all Gallery staff members are not at work. Security staff may be present somewhere in the building but not in areas that are actively being sprayed. It is unlikely that anyone would be exposed to levels of residue that could cause ill health. Exposure of Gallery staff members to dichlorvos should not have resulted in a meaningful increased risk of developing cancer.

5.7 EXTREMELY LOW-FREQUENCY ELECTRO-MAGNETIC FIELDS

Description

Extremely low-frequency electro-magnetic fields (ELFs) occur wherever electrical equipment is operated or current flows along electrical wires.

Health effects

Extremely low-frequency magnetic fields are classified as possibly being carcinogenic to humans (IARC Group 2B)[30]. This classification is based on limited evidence of an increased risk of leukaemia in children, and inadequate evidence of an increased risk of other cancer types in humans, along with inadequate evidence of carcinogenicity in animals. Extremely low-frequency magnetic fields are not classified as a human carcinogen by NOHSC[7].

Past exposures

All employees at the Gallery would have been exposed to ELFs.

The main antenna used for the Gallery radio system is located between Galleries 1 and 2, and there are other, smaller, antennae situated elsewhere around the Gallery. These are potential sources of high levels of ELF. It has been reported that in the early years of operation of the Gallery (the exact years are not known) the security guards would sit for long periods near the main antenna and elsewhere near the smaller antennae. The radio system was reportedly replaced in 1988 or 1989, but it is presumed the antennae remain in place.

Measurement of the electromagnetic fields in and around the security control room has been undertaken twice, in May 2002 and July 2005 (both done by Robson Laboratories). The summary of the 2002 report stated that "The value of the magnetic field strength measured at various work locations within the security Control Room ranged from 0.03 – 0.74 A/m (0.04 – 0.9μT). These values are significantly below the *National Interim Exposure Guidelines*. The Guidelines for the general public for continuous exposure to 50Hz magnetic fields is 80 A/m.…The magnetic field strengths are similar to typical exposure values experienced in the average US home and office areas adjacent the areas of concern….Based on these two findings which were reported within the last twelve months the likelihood of there being any long term health effects of persons occupying workplaces where levels are at or below 0.8 A/m are considered to be extremely low or negligible."

In 2005, magnetic fields were measured in the Security Room around the fire safety cabinet, which was considered likely to be the main source of electromagnetic radiation in the area. Results showed that magnetic fields were well within the NHMRC interim

guidelines on limits of exposure to 50/60 Hz electric and magnetic fields. These limits represent levels below which predicted and established immediate health effects are unlikely.

Monitoring of electro-magnetic field strengths in the Exhibition gallery (adjacent to Gallery 1) was carried out in January 2003 (by Robson Laboratories) following complaints of tiredness experienced by security guards in this area. Measured field strengths were well below the NHMRC Interim exposure guideline of 100 μT, with the maximum measured level being 0.2 μT. No adverse health effects are expected at this level of exposure.

Taking these results together, there does not appear to be any evidence, or likelihood, that Gallery staff members (or patrons) have been exposed to levels of electromagnetic fields that are likely to result in ill health.

Current exposures

Exposures should not have changed since the measurements were made between 2002 and 2005.

Conclusions

The exposure of staff and visitors to ELF is not at a level that would be expected to cause ill health. Therefore, exposure of Gallery staff members to ELF should not have resulted in a meaningful increased risk of developing cancer.

Recommendations

Routine monitoring of electromagnetic fields is probably not warranted. However, it would be wise to repeat the measurements in and around the security control room any time there is a significant change in electrical equipment in the security control room.

- *Gallery officer subsequently informed the authors that this practice would be adopted.*

5.8 MAGENTA

Description

Magenta is a dye used to colour materials.

Health effects

Magenta is classified as possibly being carcinogenic to humans (IARC Group 2B)[31], with bladder cancer being the main cancer identified as possibly being related to exposure to magenta. Magenta is not classified in terms of human carcinogenicity by NOHSC[7]

Past exposures

Magenta is a component of a dye used by the Conservation Department in the past. The circumstances of use are not certain but it is clear that exposures would only ever have been very minor.

Current exposures

Magenta-based dyes are no longer used in the Conservation Department.

Conclusions

Exposure of Conservation staff members to magenta should not have resulted in a meaningful increased risk of developing cancer.

5.9 POTASSIUM BROMATE

Description

Potassium bromate is primarily used in the preparation of dough, although it has been banned from this use in some countries.

Health effects

Potassium bromate is classified as possibly being carcinogenic to humans (IARC Group 2B)[32], but there is no human evidence relevant to occupational exposure. Potassium bromate is not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

Potassium bromate is listed in Conservation Department documents as having been used in the Gallery at some time, but it is not clear where and how it was used. There is no suggestion that it has been used in significant amounts.

Current exposures

Potassium bromate is not currently used or stored in the Gallery.

Conclusions

There is some uncertainty about the use of potassium bromate, but it appears unlikely that Gallery staff members would have been exposed to levels that could have affected their health. Therefore, exposure of Gallery staff members to potassium bromate should not have resulted in a meaningful increased risk of developing cancer.

5.10 SYNTHETIC MINERAL FIBRE

Description

Synthetic mineral fibres (SMF) is a generalised term to cover man-made vitreous fibres such as ceramic fibres, rock wool, slag wool and glass wool. They have been used to line air conditioning ducts in the Gallery.

Health effects

Synthetic mineral fibres is a generalised term to cover man-made vitreous fibres such as ceramic fibres, rock wool, slag wool and glass wool. As a group, synthetic mineral fibres are classified as possibly being carcinogenic to humans (IARC Group 2B)[33]. Lung cancer and mesothelioma are the main cancers suspected of possibly being related to exposure to synthetic mineral fibres. Synthetic mineral fibres are not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

On several occasions, SMF linings have been exposed either during removal, cleaning ducts or through accidental spillage during maintenance. Air monitoring was carried out for all of the documented incidents. Areas included the workshop, offices, Conservation Department, some Galleries and other areas, as detailed in Appendix 4. On one occasion (February 2003), tearing of insulation in an air conditioning duct resulted in the release of glass fibres into galleries. Staff members were exposed to minor levels of SMF, but air monitoring found airborne fibres to be no higher than 0.01 fibres/ml. All measured levels of airborne SMF have been below the NOHSC Standard of 0.5 fibres/ml[7].

Current exposures

Previous measurements indicate that there is no on-going exposure of staff members to SMFs in the building.

Conclusions

Gallery staff members do not appear to have been exposed to significant levels of SMF that could affect their health. Therefore, exposure of Gallery staff members to SMF should not have resulted in a meaningful increased risk of developing cancer.

5.11 WELDING FUMES

Description

Welding was intermittently undertaken in the fitter's workshop in the main workshop.

Health effects

Welding fumes are classified as possibly being carcinogenic to humans (IARC Group 2B)[34]. Lung cancer is the main cancer suspected of possibly being related to exposure to welding fumes. Welding fumes are not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

Prior to installation of the exhaust system in the metal-working part of the workshop, the welder would have been exposed to not insignificant levels of welding fume. Typically, a pedestal fan was used to blow away fumes. It was reported that welding fumes also entered the main workshop. The installation of an exhaust hood in the fitter's workshop alleviated this problem and would have also lowered the welder's exposure level.

It is not possible at this stage to estimate the level of exposure, but welding is not a routine task. So, exposure levels would have been low compared to welders in, say, the metal fabrication industries.

Current exposures

Welding is no longer carried out in the workshop and is now outsourced.

Conclusions

The fitter would have been exposed to low levels of welding fume in the past, with the possibility of instances of higher exposure. It is not possible to know definitively what that exposure level would have been, but it can be reasonably assumed that it would have been much lower than process welding, and therefore well below the exposure standard for fume. This suggests that exposure of Gallery staff members to welding fume should not have resulted in a meaningful increased risk of developing cancer.

6. POLICIES AND PROCEDURES RELEVANT TO CARCINOGENS

6.1 INTRODUCTION

The Gallery has a range of policies and procedures relevant to the use of, and potential exposure, to carcinogens. This chapter considers these policies and procedures.

6.2 RISK ASSESSMENT

The Conservation Department has a written work procedure (*NGA Standard Work Procedure (SWP) No. 63*) covering the use of potentially carcinogenic substances (dated May 2006). The purpose of the document is to define carcinogens and to monitor their use in the workplace. It is intended for use in the Conservation Department and provides an extensive list of known, probable and possible carcinogens. It also outlines procedures for handling, use, record keeping, storage and disposal of carcinogens. It provides notification and recording of usage. There is also a work procedure (*NGA Standard Work Procedure (SWP) No. 13*) which covers the use of x-ray equipment in the Gallery.

These are the only specific documents outlining procedures for carcinogens of which the authors are aware and which have been seen by them. The Gallery has previously incorporated carcinogens in the general hazardous substances registers and risk assessments. The hazardous substances register is written in a ChemWatch program. Risk assessments appear to have been done for some, but not all, substances, and this process is continuing.

The probable and possible carcinogens used in the Conservation Department are also listed. The document states that "The Conservation department at the NGA bans the use of known carcinogens at all times". Of the substances classified as probable or possible carcinogens, the following have been identified in the document as having a need for use within the department (this is not an exhaustive list, and the document identifies that all new substances need to be checked prior to purchase). The list documents cadmium and cadmium compounds, and trichloroethylene, as probable carcinogens and carbon black, carbon tetrachloride, cobalt, dichloromethane, magenta, and potassium bromate as possible human carcinogens. This list contains some errors, in that cadmium and cadmium compounds are classified by IARC as known human carcinogens, and there is

potential exposure to cadmium in the Conservation Department through the use of pigments, which means there actually is potential exposure to a known carcinogen in the Gallery. However, as noted earlier in this report, the approach to the storage and use of the cadmium pigments is largely appropriate, and is in the process of being improved (the process has been improved since this was written for the Stage One report).

Although a comprehensive inventory of chemicals in use and storage in all areas of the Gallery was not performed as part of this project, in some areas the authors did notice chemicals that were not on the relevant inventory that was shown. The updating of the chemical inventories is on-going in the Gallery and should be completed as planned. It is noted that the Conservation Department, which has the most substances of concern, appears to be well advanced in producing a complete inventory (the Gallery has completed these inventories since this was written for the Stage One report).

Gallery officers are aware of carcinogens in use and there are general procedures in place for handling hazardous substances. However, risk assessments are still required for many of the carcinogens. This process needs to continue, leading to a full risk assessment of all hazardous substances and exposures (which will cover exposure to carcinogens), and including comprehensive documentation of MSDSs (preferably in electronic form and accessible by all staff members via the Intranet), worker training, record keeping, and proper labelling, storage and disposal.

Recommendations

Complete the inventory of hazardous substances.

- *Gallery officers later informed the authors that a hazardous substances inventory had been completed, and was being reviewed. The Gallery subsequently provided further information: "A hazardous substances inventory has been completed, and reviewed. All substances identified were included in the Gallery's Hazardous Substance manifest.".*

Complete the risk assessment of hazardous substances and exposures, including comprehensive documentation of MSDSs, worker training, record keeping, and proper labelling, storage and disposal.

- *Gallery officers later informed the authors that the identified actions were to be undertaken as soon as possible. The Gallery subsequently provided further information: "The risk assessment of hazardous substances is continuing. A number of staff were trained in the use of the CHEMWATCH database in 2007, and this should assist the Gallery to manage hazardous substances.".*

7. OTHER EXPOSURES AND EXPOSURE INCIDENTS

7.1 INTRODUCTION

This section considers exposures and exposure incidents that, while probably not involving carcinogens, have been of significant concern to staff in terms of possibly increasing the risk of developing cancer.

7.2 METHYL BROMIDE

Description

Methyl bromide is used as a fumigant.

Health effects

Methyl bromide is not classifiable as to its carcinogenicity in humans (IARC Group 3) according to IARC[23], as there is inadequate evidence in humans of carcinogenicity and limited evidence of carcinogenicity in animals. Methyl bromide is not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

Methyl bromide was occasionally used as a fumigant for treating large objects. The treatment was contracted to Quarantine Services and was performed at Fyshwick. The fumigation was done in a shipping container positioned in a paddock. Gallery staff members would enter the container after one day's ventilation. Gloves were worn when handling the items. The staff would enter the container for five minutes to remove items. Removal and transfer to a vehicle could have taken about 20 minutes and some staff members might have done this up to about once per week. The practice stopped several years ago. Exposure to methyl bromide would have been minimal.

Current exposures

Methyl bromide is no longer used for fumigation and has been replaced by oxygen replacement treatments.

Conclusions

It is unlikely that Gallery staff members developed ill-health (including cancer) as a result of exposure to methyl bromide.

7.3 TRICHLOROETHANE

Description

Trichloroethane (1,1,1-trichloroethane) has many uses, including as a solvent to dissolve grease.

Health effects

Trichloroethane is not classifiable as to its carcinogenicity in humans (IARC Group 3) according to IARC[23], as there is inadequate evidence in both humans and animals of carcinogenicity. Trichloroethane is not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

As with other organic solvents used in the Conservation Department, trichloroethane was used for spot treatments of garments. In the early years of the Gallery's operation, garments were washed in a specially designed bath fitted with a canopy exhaust hood. Spot treatments were done using a range of solvents, including trichloroethane. If these were found to be effective, a more extensive cleaning of the garment would occur using a fume cupboard. Nitrile gloves were used and staff wore lab coats. When working with larger amounts of solvent, half-face organic vapour respirators would usually be worn. It appears that on rare occasions there may have been some minor skin exposure.

Trichloroethane was also used in black and white photograph development until the beginning of 1997, when it was replaced by tetrachloroethylene. The development was undertaken in a dark room with appropriate extraction ventilation. It appears that appropriate personal protective equipment (goggles and gloves) was used most of the time, although there is some suggestion of working without gloves occasionally. Few staff members were potentially exposed.

Current exposures

Costumes and garments are now dry cleaned off site occasionally. Gallery staff members are estimated to spend about one hour, five or six times per year, at the dry cleaners. Staff said that they could smell the odour of dry cleaning solvent when transporting the cleaned garments in the rear car seat back to the Gallery. Trichloroethane is still used occasionally for spot treatments, with staff using the same control measures as they have previously.

Conclusions

The staff members' exposure to vapours is expected to be well below the TWA exposure standard of 125 ppm for trichloroethane.

7.4 HYDROGEN PEROXIDE

Description

Hydrogen peroxide is a highly reactive compound that can be used for cleaning purposes.

Health effects

Hydrogen peroxide is not classifiable as to its carcinogenicity in humans (IARC Group 3) according to IARC[23], as there is inadequate evidence in humans of carcinogenicity and limited evidence of animal carcinogenicity. Hydrogen peroxide is not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

Hydrogen peroxide was used in some aspects of cleaning the air conditioning in the 1990s and early 2000s and was the subject of considerable public concern because of claims that the peroxide was not being used properly and might damage the Gallery's collections. There was also some concern about health effects on workers and members of the public. The use of hydrogen peroxide and its potential health effects have been the subject of previous occupational health and safety investigations and reports at the Gallery (see Broadbent, 2000; Maguire, 2000; Wray, 2003).

Current exposures

Hydrogen peroxide is no longer used for cleaning of the air conditioning system.

Conclusions

It is unlikely that Gallery staff members developed ill health (including cancer) as a result of exposure to hydrogen peroxide.

7.5 ISOTHIAZOLONE COMPOUNDS

Description

Isothiazolone compounds have a number of uses, including for cleaning purposes.

Health effects

Isothiazolone compounds are irritants and allergens. They are not known to be carcinogenic but have not been considered by IARC. Isothiazolone compounds have been identified as possible mutagens, although there is some debate about this[35]. Isothiazolone compounds are not classified in terms of human carcinogenicity by NOHSC[7].

Past exposures

Up until 1991, isothiazolone compounds were used to clean the air-conditioning system by being added to the spray chambers in the air stream of the air conditioning system (internal memo from Bruce Ford to Paul Read dated 11/4/1990; letter from Bruce Ford to Drugs and Poisons Scheduling Committee dated 16/1/1991). The use of isothiazolone compounds for cleaning the air conditioning system was stopped in 1991 (see Broadbent, 2000; Maguire, 2000).

Current exposures

Isothiazolone compounds have not been used at the Gallery since 1991.

Conclusions

There is no evidence that Gallery staff members developed ill-health as a result of exposure to isothiazolone, but the lack of information about exposure circumstances and levels makes it difficult to assess this definitively.

7.6 AIR CONDITIONING AND CLEANING

Concern was raised that one or more of the chemicals used to clean the air-conditioning system might have been carcinogenic. There was not a lot of information available on exactly which chemicals were used and when they were used. The two main identified chemicals of concern were hydrogen peroxide and isothiazolone compounds. These have been considered earlier in this chapter. A third substance, *Coil and Filter Cleaners AK.30*, was in use in 1995 at the time of a complaint from a staff member regarding ill health arising from exposure to a substance via the air conditioning system. An MSDS for this substance was supplied at the time by the manufacturer and indicates that the active ingredients are quaternary ammonium compounds, which are known to be irritant but not known or suspected to be carcinogenic.

7.7 AIR CONDITIONING - CELLULOSE FIBRES AND DUST IN WORKSHOP

In 2003, concern was raised about unknown fibres being expelled from the air conditioning ductwork in the workshop. The fibres had been appearing for the previous three years. Analysis of the fibres identified them as cellulose. No asbestos was found in the sample. Air monitoring was also carried out and fibre concentration found to be below the detection limit of 0.01 fibres/ml.

7.8 AIR CONDITIONING AND INDOOR AIR QUALITY

The Gallery air conditioning system experienced problems with mould and fungi accumulation which initiated several reports, including a Comcare investigation by Peter Maguire (February 2000) and another survey by Dingle & Cheong (2002).

There have been wide ranging reports of an odour or smell from the air conditioning described as "fishy", "organic" and "like garden fertiliser". The odour occurred throughout the building when the system was cleaned and serviced and lasted all day. This occurred about every two weeks. The smell gave some people headaches, sore eyes and nausea. It was reported by one interviewed staff member that the smell started in about 1983. Others reported it from around 2000. The air conditioning system was treated with various biocides and hydrogen peroxide during the period 1997 to 2001. Maguire (February 2000) concluded that the smell was similar but stronger than those emitted from reverse cycle air conditioners and attributable to human body odour, perfumes and cigarette smoke in those systems. Some members of staff commented that they thought the smell came from the mould in the system. This view is supported

by Dingle & Cheong, who stated that the odour was due to volatile organic compound (VOC) metabolites associated with microbial growth. Metabolites included higher alcohols, ketones and organic acids.

There were many indoor air quality surveys conducted between 1993 and 2005. The authors do not have records of any relevant surveys prior to that. Between these years, air monitoring for dust, asbestos, SMF, carbon monoxide, carbon dioxide, oxides of nitrogen, ozone, formaldehyde, oil mist, hydrogen sulphide, fungi, mould and Legionella was carried out in the galleries and service departments. All surveys reported contaminant levels for indoor air to be within acceptable ranges and standards set by NHMRC and NOHSC.

In 2002, the air conditioning system was overhauled and a new system of non-chemical air purification introduced using oxygen injection. To the authors' knowledge, there have been no complaints of odours since the new system was introduced.

7.9 SICK BUILDING SYNDROME

The Gallery has a long history of occupational health and safety issues, dating back to the 1980s. Many of these have been directly or indirectly connected to the air conditioning system, to the presence of moisture and mould in various areas in the building, and to the perceived general approach to occupational health and safety. The possible development of ill-health caused by problems with the air conditioning system and to the mould has raised for some the possibility of sick building syndrome. Sick building syndrome is an ill-defined description covering instances where indoor air quality is poor and leads to a range of symptoms and signs of ill health[36]. The question as to whether the Gallery was a "sick" building has been the subject of aspects of various reports and comment, but in essence the label means little and the identification of sick building syndrome is a very difficult one to either prove or disprove. Sick building syndrome is not usually connected with cancer, although there have been suggestions (but not definitive studies) that long-term exposure to volatile organic chemicals in a closed environment might increase the risk of developing cancer. The main substance implicated in this regard has been formaldehyde, as it is contained in many modern plastics, coverings and processed boarding material and can enter the atmosphere when "off-gassed" from the material. The measurements of formaldehyde taken in the Gallery have always been below the NHMRC guideline and the NOHSC exposure standard. It is considered very unlikely that indoor air exposures associated with the closed nature of the Gallery building would have resulted in an increased risk of Gallery staff members developing cancer.

7.10 CONDENSATION

Water condensation has long been a problem with the Gallery building. Water condenses on the cold concrete walls, especially in winter. This leads to mould growth which has been the subject of several surveys of bioaerosols including fungi, mites and pollen. Although bacteria and fungi were found on gallery walls, in the library and in the air conditioning ducts, their concentration in air has never been considered high enough to cause health problems.

7.11 OIL EXHIBIT

Concern was expressed by many security staff about the oil exhibit that opened at the Gallery in August 1996. This oil exhibit was a display of a reflective pool of used sump oil. The pool had a volume of approximately 13,500 litres over an area of approximately 185 m^2. The pool size was 17.5 x 9.5 metres, with a walkway extending 8 m into pool. The oil was 75 mm deep, with a total volume 12,469 litres and a density of the oil of 890 kg/m^3. The resulting mass was 11.1 metric tonnes.

The room was supplied with an extraction ventilation system. The supply air volume of 6000 L/sec was extracted through grills, ducting and six exhaust fans to the outside of the building. Fumes and vapours exuded by the oil were contained within the area bounded by the installation.

The oil contained very small amounts of benzene and polyaromatic hydrocarbons (based on the information provided in the Tri State Oil Pty Ltd MSDS). Some volatile components of the oil would have been present in the room but at a very low level. Motor oil has a low volatility and only becomes a respiratory hazard when in the form of a mist or if heated to generate vapour.

7.12 FLOOR STRIPPING

Several current and former members of staff mentioned a problem of security staff being exposed to high levels of a chemical used to strip floors. It is not clear how many such incidents there were, when they occurred, or what chemicals were involved. Some information is provided in a signed statement by a previous member of staff who described an incident that occurred in Gallery 5 on Level 6 in September 1993. The staff member reported that the floor was being stripped by janitors while staff and patrons were in the vicinity, and that several staff members and patrons were adversely affected

at the time as a result of exposure to the "fumes". The stripping agent used was reported by the staff member to be called "Assault" (manufactured by the "Blue Line Chemical Co."). Mention is made of an MSDS being obtained for the substance, but the current investigation did not identify the MSDS and the contents of the MSDS are not known. This makes it very difficult to appropriately assess the risk to ill health that might have arisen from this, and any other similar exposures. However, it is reasonable to conclude that it is very unlikely such a stripping agent would be carcinogenic. It is also very unlikely that a single exposure at levels likely in the circumstances described above would meaningfully increase the risk of developing cancer.

8. DISCUSSION OF EXPOSURE ANALYSIS

8.1 INFORMATION ON PAST EXPOSURES

From the point of view of an investigation of possible work-related cancer, it is past exposures that are relevant, because there is usually a period of years between when an exposure occurs and when a resulting cancer becomes evident. Knowledge of these past exposures provides information that might support or not support the likelihood of work-related cancers having developed amongst Gallery staff members. It also potentially influences the appropriateness of medical screening for certain diseases.

The information on past exposures came from current employees who have worked at the Gallery for many years, previous employees, and from relevant contemporaneous reports and other documents. This was supplemented by observations made during the site visits and questions regarding what things might have changed between previous years and currently. Information from current and former staff members is likely to contain some error due to the staff members having to remember past events, in some cases from many years previously. Information from documents is likely to be more accurate, but not all the information of interest, especially information on the level of exposures, was available. In addition, the earliest relevant report used by the study team was from 1990 (apart from reports on the Nuralite roof), and the study team is not aware of any relevant reports produced prior to that time. However, the study team placed considerable emphasis on obtaining information about these early years during the interviews of current and former staff. Probably the biggest area lacking information is information on chemicals used to clean the air conditioning system in the past. Some information on this was obtained, but this was incomplete and didn't cover the entire period from when the Gallery opened to when the new system was installed several years ago. There were also concerns expressed about substances used to strip, or to polish, floors in the Gallery. The relevant substance was identified in once instance, but it is not known if this was the same substance used in all cases of floor stripping. Despite this uncertainty, it seems very unlikely that the relevant agents would have been probable carcinogens, and also unlikely that the exposure levels would have been such as to realistically raise the possibility of an exposed person developing cancer as a result of the exposure.

Taking into account the inaccuracies in the data, it is unlikely that Gallery staff members were significantly exposed to carcinogens or probable carcinogens that are not documented in this report.

8.2 INFORMATION ON CURRENT EXPOSURES

Knowledge of past exposures is not directly relevant to the health and safety of current staff. It is probably of most use to staff to know about current exposures, as any problems with these can and should be corrected as soon as possible. Information on current exposures came from current employees and from relevant records and other documents, as well as from the site visits.

Available information on current exposures was comprehensive and generally included information on exposure levels where relevant. It is very unlikely that Gallery staff members are significantly exposed to carcinogens or probable carcinogens that are not documented in this report. There are some exposures for which further information would be useful, and these are documented in the relevant section.

8.3 INPUT FROM CURRENT AND PREVIOUS GALLERY STAFF MEMBERS

All current staff members were requested several times by management to provide information to the study team if they were interested or felt they had relevant information to contribute. Many staff members did so, but they represented a little under 10% of the total current Gallery staff members. Although this appears a small percentage, the input was proportionately much greater from areas that a priori were thought to be at highest risk of exposure or that had the highest levels of concern (Conservation staff, security staff, workshop staff, storage and receiving staff). Input from former staff members was restricted to several people with a long-running interest in health and safety at the Gallery and to a few who had heard about the project through word of mouth, the press or the Gallery web site.

Several people who were interviewed expressed concern that others who might have relevant information would not co-operate with the project because they feared their jobs at the Gallery would be threatened in some way. This concern seemed to be based on a perception that the careers of other Gallery staff members had suffered as a result of raising occupational health and safety matters of concern. The study team received assurances from Gallery management that such perceptions were unfounded and staff members were encouraged by management to co-operate. The team did not witness or hear of any situations that suggested the concerns were warranted now, and is not in a position to comment on whether such concerns might have been warranted previously. There was one instance early in the project where a staff member was spoken to in relation to a matter connected with the project, but this appeared to relate to a more general occupational health and safety matter rather than to the project per se, and the matter appeared to have been resolved appropriately.

8.4 ACCESS TO RELEVANT DOCUMENTS

Several persons who were interviewed expressed concerns that the study team would not be given access to all relevant reports. In an attempt to ensure that the study team did have access to all relevant reports, the study team supplied to the Steering Committee a list of all reports to which they had been given access. The Steering Committee in return identified any reports missing from this list and which were potentially relevant. These reports were obtained and read, and relevant aspects of them included in preparing this report.

8.5 LIMITATIONS OF THE FINDINGS ON EXPOSURES

It should be noted that the findings in this report are based on information from current and former staff, information obtained in reports, and the observations of the study team. The site visit approach was comprehensive, and included looking in all the cupboards and storage areas noted by staff and identified during the visits. The study team are confident that there are no significant quantities of carcinogens of which they are not aware. They are also satisfied that staff members are not meaningfully exposed to carcinogens except as identified and described earlier in this report. It is possible that there are small quantities of hazardous substances (including carcinogens) that were not identified during the study because they were not on the chemicals register, not stored in the known cupboards or storage areas, not mentioned in the previous reports, and not known to the current and former staff members who provided information for this study. Only a complete inventory of chemicals in use and storage within all areas of the Gallery would provide such information. Performing a complete inventory is a major task. Since this study was focussed only on carcinogens rather than all hazardous substances, and the conduct of a complete inventory was not considered necessary for the current study, such a complete inventory was not conducted as part of this study. However, as stated earlier, it was recommended in the Stage One report that a complete inventory of all hazardous substances in the Gallery be performed, and the Gallery have since informed that authors that this has been undertaken.

This study has not identified any exposures or exposure circumstances that raise concern that significant exposure to carcinogens has occurred to any current or former Gallery staff member. As a result, the study has not suggested that it is likely that current or former Gallery staff members will have (or have had) a meaningful increase in their risk of developing cancer as a result of their exposures whilst working at the Gallery. Nevertheless, exposure to carcinogens has clearly occurred at times and, as with virtually any occupational exposure, an increase in risk due to the exposures can not be

completely ruled out, even though the exposures appear to have been well below the relevant exposure limit.

The only way such increased risk can be completely ruled out would be to completely eliminate the relevant exposure. For some exposures, elimination is the appropriate response, and this appears to have been the approach adopted by the Gallery for many of the carcinogenic exposures. However, for many exposures the elimination of the exposure is not feasible. Instead, the exposure needs to be kept as low as possible and the number of persons exposed should be kept as low as possible. It appears that the control measures now in place in the Gallery do this, with the possible exception of the exposure to diesel exhaust in the delivery area.

No further investigation of current or previous exposures in the Gallery building is likely to provide further useful information in regards to the aims of the current study.

9. ASSESSMENT OF CASES OF CANCER AMONGST GALLERY STAFF MEMBERS

9.1 INTRODUCTION

In assessing the likelihood of particular cancers being related to occupational exposures, there are several concepts that can usefully be considered.

Rare cancers, or more common cancers occurring at an unusual age (usually this means at a young age), provide cause for concern because they are uncommon occurrences. In contrast, common cancers, and cancers that occur at the expected age (usually in middle-aged and elderly people), are not unusual and would usually give less cause for concern.

Different types of cancer should not usually be grouped together because cancer is not a single disease and different cancer types are expected to have different risk factors or causative exposures. Some exposures, such as smoking, may be risk factors for several different types of cancers, but most exposures have only been confidently associated with one or two cancer types. Therefore, grouping all cancers together as a "cluster" that must be due to one or two exposures would usually not be a sensible approach in most occupational settings where there usually are a very limited number of exposures of concern. However, such grouping not uncommonly occurs in cluster investigations because there are too few cases of any individual cancer type to analyse separately.

One particular issue of importance is latency. Nearly all cancers have a considerable latency – the time between first exposure and the diagnosis of the disease. For most exposures leading to cancers, latencies are typically of the order of ten or fifteen years at least. So, cases that occur within this latency period (e.g. cases that occur within the first five years of exposure) are very unlikely to be due to exposure. Therefore, an apparent cluster in which most cases occurred within the expected latency period is unlikely to be due to the exposure of concern.

In addition, the risk of developing cancer is nearly always dose-dependent. That is, the higher the exposure the higher the risk. Any cluster related to work would be expected to show greater risk with longer periods of employment or higher levels of exposure. Therefore, an apparent cluster in which most cases occurred early after exposure is much less likely to be related to that exposure than is a cluster in which the bulk of the cases occur in persons who have been exposed for many years and/or at higher levels.

Important statistical concepts

This investigation was undertaken because of staff concern that there was an increased rate of cancer in Gallery staff members, particularly security staff, and that this increased rate may have been due to exposures in the Gallery. In other words, there was concern that there was a work-related cluster of cancer in Gallery employees.

A cancer cluster is simply the occurrence of cancer in greater numbers than would be expected in a given population over a given period of time. Provided that the necessary information is available, it is usually straightforward to calculate a rate of cancer in the population of interest and to see whether this rate is different to what would be expected in the general population. This is commonly achieved by using the Standardised Incidence Ratio, as was done in this investigation.

However, differences can occur between two populations just due to chance. There are known factors that increase or decrease the risk of developing cancer, but for anyone with a given set of risk factors there is a random (chance) element as to whether and when that person will develop a particular cancer. This means that another study looking at exactly the same population with exactly the same exposures and exactly the same risk factors could find a different rate of cancer because the rate of cancer for a population will vary over time and place for random reasons. If differences can occur at random, how can it be known whether an identified difference is due to a truly different risk of developing cancer or just due to random variation? The key wording in deciding whether this increased (or decreased) rate constitutes a "cluster" is "than would be expected". A higher number of cases that has arisen due to random variation is expected in a certain proportion of populations and at certain times, and a raised rate on its own would not usually be seen as a cluster. Whether the rate is higher because the population is different in some important way (e.g. because one or more exposures have increased the risk of developing cancer), or whether a rate is higher due to random factors, is a very difficult question to answer. Statistical tests are used to try to take account of this random aspect.

The basis of these statistical tests is as follows. There is a true underlying rate of cancer in any population, but each time a study is undertaken it is only possible to make an estimate of this true underlying rate because of the random factors and because the population being studied is just a sample of all the possible similar populations. Any result found in a single study might be a little bit higher or a little bit lower than the true result. Provided the study is well conducted, including more people in the study will make it more likely that the study result is closer to the truth.

A common statistical measure used in this situation is the confidence interval, which essentially provides the range in which the true result probably lies, with a certain degree of confidence. Usually the 95% confidence interval is used. Essentially, this is the range in which the true result can be assumed to lie 95% of the time. If an estimate of the difference between populations lies has a 95% confidence interval which includes the value where the populations are the same, there is little evidence that the two populations are different. The difference is said to not be "statistically significant" and it is assumed that any differences have probably arisen due to chance. If the confidence interval does not include the value where the two populations are the same, it is assumed that the measures really are different and the difference is said to be "statistically significant". However, neither conclusion can ever be known for sure. It can only be accepted with greater or lesser confidence, depending on the result of the statistical tests.

One of the assumptions underlying the statistical tests is that the population that is being tested has been randomly selected. This raises difficulties in most apparent cancer cluster investigations because the population of interest is not chosen at random. Usually it is chosen because information of some sort has suggested that the population has a higher rate of cancer than would be expected. In such a situation, it would not be surprising to find a high rate, but the statistical tests cannot be interpreted easily. In such a situation the true confidence intervals will be wider than those calculated using the usual approaches, but there is no good way of knowing how much wider to make them. There is no accepted method to allow this statistical comparison to be made with confidence. Suggestions have been made as to how this might be done, taking into account the potential for multiple testing[37]. In essence, these attempt to identify how many possible small populations the size of the study population (the one in which a cluster is suspected) can be identified, and then to adjust the initial confidence interval or p-value using this number. These approaches to adjustment have some theoretical basis but cannot properly deal with all the methodological concerns.

The usual approach to the analysis in this situation is to undertake the normal statistical testing, but to keep in mind that the results probably exaggerate the importance of any difference. More importantly, the key aspect of the analysis of any cluster is to not rely simply on the statistical testing, but to look at other aspects of the investigation, such as the presence or absence of concerning exposures, the relationship of cancers to the amount of exposure and the time since exposure, and the type and characteristics of the identified cancers.

9.2 APPROACH TO ANALYSIS

Age and gender-standardized rates for cancer overall were calculated by indirectly standardizing to Australian cancer incidence rates. Australian data were the average rates from 1982 to 2004 inclusive, which is the at-risk period used in the main analyses. These data came from the Australian Institute of Health and Welfare (AIHW) cancer data web site*.

In brief, standardization is a process that allows the actual rate of cancer to be compared to the rate of cancer that would be expected if the group of interest (in this case the past and present Gallery employees) had the same rate of cancer as a comparison population (in this case the Australian population). The analyses usually take into account differences in age and gender between the populations.

With indirect standardization, the number of cases of cancer that would be expected (the *'Expected'*) is calculated and compared to the number of cases that was identified or observed (the *'Observed'*). The Observed cases are then divided by the Expected cases. This fraction is called the Standardised Incidence Ratio or SIR. If the SIR is more than one, it means the study population has a higher rate of cancer than would have been expected if the members of the population had the same age and gender distribution and the same risk of cancer as the Australian population. If the SIR is less than one, the study population has a lower risk. If the SIR is approximately equal to one, the risk of cancer in the two populations is similar.

To determine the number of Expected cases, it is necessary to know how long people were at risk of developing cancer. Since the concern in this study was that there was a work-related exposure in the Gallery building that increased the risk of cancer for some or all work groups, the period at risk could not start until the person had started work in the Gallery building. Once the person has started work, they remain at risk until the end of the follow-up period or until they die, whichever comes first. In analyses of individual cancer type, it is usual to stop the at-risk period when the person develops the cancer of interest. In analyses comparing the rate of all cancers, it is not necessary to stop the at-risk period when a cancer develops, as the person remains at risk of developing a subsequent cancer (as happened with six subjects in this study). The end of the follow-up period is determined by the available information. If the cases of cancer are identified (as they were in this study) via a cancer registry, the follow-up period is the latest time to which the registry is complete.

As mentioned earlier, most cancers have a latency period of many years between when an exposure occurs and when a resulting cancer is diagnosed. This latency period is typically of the order of ten or fifteen years, and thought to be rarely less than five years. Therefore, it is appropriate in some analyses to not count the period at risk until the expected minimum latency period has been passed. For example, if the minimum latency period is thought to be five years, the first five years after the start of work would not be counted in the calculation of the at-risk period. For the same reason, any cancer cases that occurred in the first five years after starting work would not be counted as a case. The same approach can be used for other latency periods (say ten or fifteen years). A difficulty with this approach is the true latency is usually not known, and taking latency into account decreases the at-risk period and the number of eligible cases, which can make the analysis more difficult to conduct and interpret.

Determining the at-risk period

Staff first moved into the NGA building in late 1981. Therefore, the at-risk period was defined as beginning on 1/1/1982.

Cancer incidence data were available from the AIHW for the period 1/1/1982 until 31/12/2004. Therefore, the at-risk period extended no longer than 31/12/2004. This meant that the study period was 1/1/1982 to 31/12/2004, giving a maximum period of follow-up of 23 years.

Employment data were provided for all current and past employees by the Human Resources section of the Gallery. This information was current to 30/9/2007. Information on early employees had to be obtained by matching names to other information contained on microfiche. The required information to determine the at-risk period (date of first employment) was missing for some past employees. These people had to be excluded from the analysis because their at-risk period could not be calculated. In the small number of instances where more than one period employment during the study period was recorded, the first period was used in the analysis.

Persons employed before 1/1/1982 were eligible for the study as long as they were still employed on or after 1/1/1982. The at-risk period started on 1/1/1982 for people already employed prior to this date, or on the first day of their employment if they were employed on or after 1/1/1982.

The at risk period continued until 31/12/2004 unless the person died, in which case the at-risk period ended on the day the person died. For analyses of individual cancer types,

[*] From http://www.aihw.gov.au/cognos/cgi-bin/ppdscgi.exe?DC=Q&E=/Cancer/canceragerateSv2007 - accessed in August 2008.

the at-risk period for cases ended when the person was diagnosed with that cancer type. Persons still employed after 31/12/2004 were eligible for the study, but only if they were employed for at least one day prior to 31/12/2004. The at-risk period finished on 31/12/2004 even if the person continued in employment after 31/12/2004. Each year of employment contributed one person-year of being at risk in the relevant age-range. No distinction was made between casual, part-time and full-time employment.

For each person, the time at-risk was determined for five year age groups from 15-19 years to 85-89 years inclusive. The total time at-risk (calculated in person-years) for an age-group was determined by adding-up the amount for that age-group for all persons. This was done separately for males and females.

Determining the expected number of cases

The expected number of incident (new) cancer cases for each gender was determined by multiplying the number of person-years in each five-year age group for that gender by the relevant Australian rate for that gender in the corresponding age group, and adding the result for all age-groups. This was done separately for males and females.

The standardized rate for each gender and overall was calculated by dividing the Observed number of cases (described above) by the Expected number of cases. Ninety-five per cent confidence intervals were calculated assuming a Poisson distribution.

Standardized incidence rates for all cancers combined were calculated separately for males, females and persons (i.e. males and females combined). Separate rates for particular cancer types were also calculated. This was done for bowel cancer (in males and persons), lung cancer (in males, females and persons), melanoma (in females and persons), breast cancer (in females) and prostate cancer (in males). Separate rates could not be calculated for other cancer types because the number of cases was too low to allow reliable rates to be determined. Some separate analyses were also conducted for security officers.

Determining the observed number of cases

In Australia, all persons diagnosed with a cancer (except non-melanoma skin cancer) are required by law to be notified to the relevant State or Territory cancer registry. Information recorded for each notification includes personal information such as name, gender, date of birth and address; and information relevant to the cancer, such as the cancer type, the date of diagnosis and, where relevant, the date of death. This information is collected and owned by the relevant State or Territory cancer registry but is also provided to the AIHW, where it is combined to form the National Cancer Statistics Clearing House (NCSCH). The NCSCH can be searched for information about cancer in individuals for bone-fide research or public interest purposes, provided that the ethics

committees of the relevant State or Territory cancer registries and the AIHW ethics committee have provided ethics clearance. This ethics clearance was obtained for this study, as explained elsewhere in this report (Section 2.7).

The names of all ex-employees (whether or not they were later excluded), and all current employees who gave written informed consent to participate in the study, were sent to the AIHW. The names were matched to the data contained in the NCSCH and a list of persons with a definite or probable match was provided to the lead researcher. At the time of matching the NCSCH was current to 31/12/2004. The Victorian Cancer Registry required that the data matching for Victorian cases be done by the Victorian Registry. However, the Victorian Registry results were the same as those obtained for Victorian cases via the NCSCH, and the Victorian Registry agreed that the AIHW could provide the data directly to the lead researcher. The data for all States and Territories were provided by the AIHW to the lead researcher in late May 2008.

Cases were eligible for inclusion if they occurred on or between 1/1/1982 and 31/12/2004. Cases that occurred prior to 1/1/1982 were excluded because the persons had not been exposed to work in the building prior to the development of the cancer. Cases that occurred after 31/12/2004 were excluded because that was the latest date covered by the NCSCH at the time of data extraction.

9.3 FINDINGS

The original population

There were 2,112 staff members employed at the National Gallery for some time between 1/1/1982 and 31/12/2004. Just over half of these (58%) were female and 80% were eligible for inclusion in the study (Table 4). Security staff members comprised 12% of the total (Table 5). Two hundred and ninety-two (14%) of the staff members were current workers as at 30/9/2007, with the remainder (1,820) having ceased employment before this date.

Table 4 Persons ever employed at the National Gallery – by gender and eligibility.

	Eligible		Ineligible		All persons	
Gender	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Male	730	43.3	159	37.4	889	42.1
Female	957	56.7	264	62.1	1,221	57.9
Persons[1]	**1,687**	**100.0**	**425**	**100.0**	**2,112**	**100.0**

1: Gender was not known for two employees (both ineligible).

Table 5 Persons ever employed at the National Gallery – by work area and eligibility.

	Eligible		Ineligible		All persons	
Work area	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Security	223	13.2	31	7.3	254	12.0
Conservation	90	5.3	15	3.5	105	5.0
Building services	82	4.9	12	2.8	94	4.5
Registration	52	3.1	21	4.9	73	3.5
Workshop	18	1.1	0	-	18	0.9
Other	1,125	66.7	167	39.3	1,292	61.2
Unknown	97	5.8	179	42.1	276	13.1
Total	**1,687**	**100.0**	**425**	**100.0**	**2,112**	**100.0**

Excluded persons

Four hundred and twenty five (20%) of the original 2,112 current or past employees had to be excluded from the analysis. People were excluded from the analysis for one or more of the following reasons:

- current employees who did not return their written consent forms (122);
- current employees who refused consent (8);
- employees without a commencement date (151);
- employees without a known date of birth (19);
- employees whose latest employment finished before 1/1/1982 (35); and
- employees whose earliest employment was after 31/12/2004 (145).

The at-risk (eligible) population

One thousand six hundred and eighty-seven persons were eligible for inclusion in the analysis. Nine hundred and fifty seven (57%) of the persons were female and 730 (43%) were male. The mean age at the beginning of follow-up was 32.6 (s.d. = 10.9) years, and the mean age at the end of follow-up was 45.9 (s.d. = 13.11) years.

Ninety-three per cent of eligible people were past employees and the remainder current employees as at 30/9/2007.

Employment time

Nearly half the staff members were employed for less than one year and 79% were employed for less than five years. The mean employment time was 3.3 years (s.d. = 4.8) and the median employment time was about one year (Table 6).

Table 6 Employment time for eligible employees at the National Gallery.

	Number	Per cent
Less than 1 year	801	47.5
1 year	216	12.8
2 years	143	8.5
3 years	101	6.0
4 years	72	4.3
5 - 9 years	187	11.1
10 – 14 years	80	4.7
15 – 19 years	55	3.3
20 – 23 years	32	1.9
Total	**1,687**	**100.0**

Work area

Security (223 people – 13%) and Conservation (90 people – 5%) were the main specific areas of interest in terms of potential exposures. Building services, Registration and the Workshop were the other areas that were identified separately in the analyses because they were situated in parts of the building, or in work processes, that had been identified by one or more persons as being of concern. All other areas were combined into an "Other" group. The work area was unknown for 6% of eligible persons (Table 7)

Table 7 Work area for eligible employees at the National Gallery – by gender.

	Male		Female		Persons	
Area	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Security	144	19.7	79	8.3	223	13.2
Conservation	20	2.7	70	7.3	90	5.3
Building services	64	8.8	18	1.9	82	4.9
Registration	23	3.2	29	3.0	52	3.1
Workshop	18	2.5	0	-	18	1.1
Other	419	57.4	706	73.8	1,125	66.7
Unknown	42	5.8	55	5.8	97	5.8
Total	**730**	**100.0**	**957**	**100.0**	**1,687**	**100.0**

Time-at risk

Fifty-nine per cent of staff members were followed up for ten years or more. The mean follow-up time was 13.2 years (s.d. = 7.5) and the median follow-up time was in the range 10 to 14 years (Table 8).

Table 8 Follow-up time for eligible employees at the National Gallery.

	Number	Per cent
Less than 1 year	53	3.1
1 year	62	3.7
2 years	71	4.2
3 years	90	5.3
4 years	87	5.2
5 - 9 years	299	17.7
10 – 14 years	227	13.5
15 – 19 years	334	19.8
20 – 23 years	464	27.5
Total	**1,687**	**100.0**

About half of the follow-up time was in persons less than 40 years of age and about 15% was in persons 50 years or older (Table 9). Security staff members contributed 14% of the follow-up time but the bulk (69%) of follow-up time came from people in a range of occupations covered by the "Other" area (Table 10).

Table 9 Person-years of follow-up for eligible employees at the National Gallery – by age and gender.

	Male		Female		Persons	
Area	**P-years[1]**	**Per cent**	**P-years**	**Per cent**	**P-years**	**Per cent**
Under 24	686	6.8	918	7.5	1,604	7.2
25 to 29	1,244	12.3	1,572	12.9	2,817	12.6
30 to 34	1,535	15.2	1,792	14.7	3,327	14.9
35 to 39	1,608	15.9	1,870	15.3	3,478	15.6
40 to 44	1,494	14.8	1,755	14.4	3,249	14.6
45 to 49	1,152	11.4	1,445	11.9	2,598	11.6
50 to 54	820	8.1	1,146	9.4	1,966	8.8
55 to 59	635	6.3	811	6.7	1,446	6.5
60 to 64	469	4.6	451	3.7	920	4.1
65 to 69	263	2.6	245	2.0	508	2.3
70 to 74	148	1.5	125	1.0	273	1.2
75 to 79	50	0.5	48	0.4	97	0.4
80 to 84	7	0.1	13	0.1	20	0.1
85 to 89	0	0.0	3	0.0	3	0.0
Total	**10,112**	**100.0**	**12,194**	**100.0**	**22,306**	**100.0**

1: Person-years.

Table 10 Person-years of follow-up for eligible employees at the National Gallery – by work area and gender.

Area	Male		Female		Persons	
	P-years[1]	Per cent	P-years	Per cent	P-years	Per cent
Security	2,034	20.1	1,082	8.9	3,117	14.0
Conservation	303	3.0	682	5.6	985	4.4
Building services	1,087	10.7	335	2.7	1,422	6.4
Registration	247	2.4	379	3.1	626	2.8
Workshop	299	3.0	0	0.0	299	1.3
Other	5,894	58.3	9,476	77.7	15,371	68.9
Unknown	248	2.5	238	2.0	486	2.2
Total	**10,112**	**100.0**	**12,194**	**100.0**	**22,306**	**100.0**

1: Person-years.

Eligible cases

Seventy-six persons were identified by the NCSCH as having been diagnosed with cancer. Six of these persons had two incident cancers. Two other persons self-identified as having been diagnosed with cancer. Both these persons were diagnosed after 2004 and therefore would not have been identified by the NCSCH matching process. One other person was reported to have developed (and later died from) cancer. Information about the diagnosis was limited, but it appears the diagnosis was made after the person had moved overseas and after 2004, both reasons why the person would not have been identified by the NCSCH matching process.

The available information therefore identified 79 persons who had been diagnosed with cancer (a total of 85 incident (new) cases because six persons had two incident cancers identified). Of these 79, 22 (all of whom had only one cancer identified) had cancers that were ineligible for inclusion:

- seven persons ceased employment at the National Gallery before 1/1/1982;
- seven persons were diagnosed with cancer before they commenced work at the National Gallery;
- three persons were diagnosed after 31/12/2004 (one of whom was resident outside Australia at the time and was diagnosed outside Australia);
- for five persons the documentation on the working period was not complete enough to allow them to be included in the analysis (The five persons had breast cancer (four persons) and testicular cancer.).

This left 57 persons (63 incident cancers) for inclusion in the analysis. Thirty-one (54%) persons were male and 26 female.

Case type

Nineteen different types of cancer were identified. The most common types of cancer overall and in eligible cases were breast cancer, bowel cancer, lung cancer, prostate cancer and melanoma. Nearly half the breast cancer cases were ineligible for inclusion, four due to inadequate employment information, as mentioned (Table 11).

Table 11 Types of cancer diagnosed in employees at the National Gallery – by eligibility for inclusion.

	Eligible	Ineligible	Total
Breast	12	11	23
Bowel	9	1	10
Lung	9	1	10
Prostate	8	1	9
Melanoma	5	2	7
Hodgkin's Lymphoma	3	1	4
Pancreas	3	0	3
Testis	2	1	3
Bladder	2	0	2
Cervix	2	0	2
Kidney	2	0	2
Eye	1	0	1
Kaposi' sarcoma	0	1	1
Naso-pharynx	0	1	1
Non- Hodgkin's Lymphoma	1	0	1
Ovary	1	0	1
Peripheral nerve	0	1	1
Thyroid	0	1	1
Uterus	1	0	1
Unspecified	2	0	2
Total	**63**	**22**	**85**

Age at diagnosis

The mean age at diagnosis was 55.6 years (s.d. = 13.7) and ranged from 23 to 78 years. Males (59.4 years; s.d. = 12.9 years) were older at diagnosis than females (51.2 years, s.d. = 13.5 years). The mean age at diagnosis for people eligible for inclusion as cases is shown in Table 12 for the five main cancer types identified. Australian data are supplied for comparison. This shows that Gallery employees were somewhat younger at diagnosis than the general public, but this is almost certainly because to be included in the study the Gallery employees had to be have been working in the last two decades and so most would not have had time to grow old during the course of the study, whereas there was no such limitation on persons in the Australian population.

Table 12 Mean age at diagnosis for all cancers and selected cancers – eligible employees at the National Gallery and Australian population in 2004.

	Gallery employees mean (sd[1])		Australian population[2]
Breast	49.2	(12.0)	60.5
Bowel	62.7	(3.7)	69.6
Lung	61.3	(12.2)	70.3
Prostate	67.1	(5.7)	69.5
Melanoma	47.8	(14.5)	60.1
All cancers	55.6	(13.7)	65.7

1: Standard deviation.

2: Information taken from Australian Cancer Incidence and Mortality (ACIM) books (http://www.aihw.gov.au/cancer/data/acim_books/index.cfm)

Work area

Seventeen of the persons who were diagnosed with cancer worked as security officers and twenty-eight worked in one of the various areas grouped under "Other" (Table 13).

Table 13 Work area for persons diagnosed with cancer – eligible employees at the National Gallery.

Work area	Persons	Per cent
Security	17	29.8
Conservation	1	1.8
Building services	4	7.0
Registration	3	5.3
Workshop	3	5.3
Other	28	49.1
Unknown	1	1.8
Total	**57**	**100.0**

Latency

The minimum time between starting work in the Gallery building and being diagnosed with cancer was 0.4 years and the maximum time was just under 23 years (the maximum follow-up time possible). Thirteen (23%) people had a latency of less than five years and 23 (40%) had a latency of less than ten years (Table 14).

Table 14 Latency[1] for persons diagnosed with cancer - eligible employees at the National Gallery.

	Number	Per cent
Less than 1 year	3	5.3
1 – 4 years	10	17.5
5 - 9 years	10	17.5
10 – 14 years	17	29.8
15 – 19 years	15	26.3
20 – 23 years	2	3.5
Total	**57**	**100.0**

1: Only the first cancer is included for persons diagnosed with two cancers.

The mean latency for all cancers was 11.0 (s.d. = 6.1) years, with a range from 9.1 years to 15.6 years for the five main cancer types (Table 15).

Table 15 Mean latency[1] for all cancers and selected cancers – eligible employees at the National Gallery.

	Mean (sd[2]) (years)
Breast	9.1 (4.9)
Bowel	10.3 (5.6)
Lung	9.1 (7.3)
Prostate	15.6 (5.1)
Melanoma	11.3 (6.2)
All cancers	**11.0 (6.1)**

1: Only the first cancer is included for persons diagnosed with two cancers.
2: Standard deviation.

Main analysis

An SIR equal to one means that the estimated rate of cancer in Gallery employees was the same as that for all Australians, taking into account differences in age and gender. An SIR greater than one suggests the rate was higher in Gallery employees. An SIR of less than one suggests that the rate was lower in Gallery employees.

The estimated rate of cancer, whether overall or for individual cancers, was similar in Gallery employees compared to the Australian population, taking into account differences in age and gender (Table 16).

The estimated SIR was lower for some cancers and higher for others, but for all the analyses the 95% confidence intervals (which provide information on the range in which the true result probably lies) suggested that any differences between the Gallery rates and the Australian rates may well have arisen due to chance.

The overall rate of cancer in Gallery employees was estimated to be 14% lower than the cancer rate in the Australian population. The SIR was more than one for lung cancer (44% higher), bowel cancer (6% higher) and prostate cancer (44% higher). The SIR was less than one for breast cancer (15% lower) and melanoma (48% lower) (Table 16).

Table 16 Standardised[1] rates for incidence of all cancers, and selected cancer, for eligible employees at the National Gallery. Standardised to Australian rates. Standardised incidence ratio and 95% confidence interval – by gender.

Cancer type	Gender	Expected[2]	Observed[3]	SIR[4]	95%CI[5]
All cancers	Females	38.5	29	0.75	0.50 – 1.08
All cancers	Males	35.0	34	0.97	0.67 – 1.36
All cancers	Persons	73.5	63	0.86	0.66 – 1.10
Lung cancer	Females	2.0	3	1.52	0.30 – 4.47
Lung cancer	Males	4.3	6	1.41	0.52 – 3.08
Lung cancer	Persons	6.2	9	1.44	0.66 – 2.74
Bowel cancer	Females	3.9	1	*	*
Bowel cancer	Males	4.6	8	1.74	0.76 – 3.43
Bowel cancer	Persons	8.5	9	1.06	0.48 – 2.00
Melanoma	Females	5.0	4	0.80	0.22 – 2.05
Melanoma	Males	4.6	1	*	*
Melanoma	Persons	9.6	5	0.52	0.17 – 1.22
Breast cancer	Females	13.0	11	0.85	0.42 – 1.52
Prostate cancer	Males	4.7	8	1.44	0.63 – 2.85

1: Standardised by age and gender.

2: Number of cases expected.

3: Number of cases observed.

4: SIR = Standardised Incidence Ratio.

5: 95% CI = 95% confidence interval.

*: Too few cases to allow meaningful SIR to be calculated

Analysis assuming a five-year latency

The analysis was repeated assuming that at least five years from the date of first exposure was required before a cancer due to that exposure could have been diagnosed. This analytical approach meant that number of Observed cases was lower - less cancers were eligible because cancers that were diagnosed within five years of starting work at the Gallery were deemed not to have been possibly related to Gallery exposures. Similarly, the at-risk period was less because the first five years following work at the Gallery were not included. This meant that the Expected number of cases was also decreased. The results were similar to the analysis with no latency (Table 17).

Table 17 Standardised[1] rates for incidence of all cancers, and selected cancer, for eligible employees at the National Gallery – assuming a five year latency. Standardised to Australian rates. Standardised incidence ratio and 95% confidence interval – by gender.

Cancer type	Gender	Expected[2]	Observed[3]	SIR[4]	95%CI[5]
All cancers	Females	30.1	23	0.77	0.49 – 1.15
All cancers	Males	28.8	27	0.94	0.62 - 1.36
All cancers	Persons	58.9	50	0.85	0.63 – 1.12
Lung cancer	Females	1.6	2	*	*
Lung cancer	Males	3.6	5	1.39	0.45 - 3.26
Lung cancer	Persons	5.2	7	1.35	0.54 - 2.79
Bowel cancer	Females	3.1	1	*	*
Bowel cancer	Males	3.8	5	1.32	0.42 - 3.09
Bowel cancer	Persons	6.9	6	0.87	0.32 - 1.90
Melanoma	Females	3.4	3	0.88	0.18 - 2.59
Melanoma	Males	3.5	1	*	*
Melanoma	Persons	6.9	4	0.58	0.16 - 1.48
Breast cancer	Females	9.8	10	1.02	0.49 - 1.89
Prostate cancer	Males	4.8	8	1.67	0.73 - 3.30

1: Standardised by age and gender.

2: Number of cases expected.

3: Number of cases observed.

4: SIR = Standardised Incidence Ratio.

5: 95% CI = 95% confidence interval.

*: Too few cases to allow meaningful SIR to be calculated.

Analysis assuming a ten-year latency

The analysis was also repeated assuming that at least ten years from the date of first exposure was required before a cancer due to that exposure could have been diagnosed. As with the five-year latency approach, this meant that less cancers and less follow-up time were included. The smaller numbers meant the confidence intervals were wider and the results harder to interpret, but the results were again similar to the analysis with no latency (Table 18).

Table 18 Standardised[1] rates for incidence of all cancers, and selected cancer, for eligible employees at the National Gallery – assuming a ten year latency. Standardised to Australian rates. Standardised incidence ratio and 95% confidence interval – by gender.

Cancer type	Gender	Expected[2]	Observed[3]	SIR[4]	95%CI[5]
All cancers	Females	20.8	16	0.77	0.44 – 1.25
All cancers	Males	21.2	24	1.13	0.73 – 1.68
All cancers	Persons	42.0	40	0.95	0.68 – 1.30
Lung cancer	Females	0.8	1	*	*
Lung cancer	Males	2.2	4	1.79	0.49 – 4.57
Lung cancer	Persons	3.1	5	1.64	0.52 – 3.83
Bowel cancer	Females	1.6	1	*	*
Bowel cancer	Males	2.3	4	1.77	0.49 – 4.52
Bowel cancer	Persons	3.9	5	1.30	0.42 – 3.04
Melanoma	Females	1.4	2	*	*
Melanoma	Males	1.9	1	*	*
Melanoma	Persons	3.3	3	0.92	0.18 – 2.70
Breast cancer	Females	4.7	6	1.28	0.47 – 2.79
Prostate cancer	Males	3.0	7	2.31	0.92 – 4.76

1: Standardised by age and gender.

2: Number of cases expected.

3: Number of cases observed.

4: SIR = Standardised Incidence Ratio.

5: 95% CI = 95% confidence interval.

*: Too few cases to allow meaningful SIR to be calculated.

Analysis of rates for security personnel

The estimated all-cancer rate was 23% higher in security officers than the Australian population, but as with the other estimates the confidence intervals suggested that the apparent increase could easily have been due to chance. However, the estimated rate of bowel cancer was three and a half times higher in security personnel, with seven Observed cases and only two Expected cases, and the confidence intervals did not cross one, suggesting that the rate may not have been high just due to chance and that the underlying rate may truly have been higher. This increased rate was primarily due to an excess number of cases in male security officers. The estimated rate of prostate cancer was 80% higher than the Australian male population rate but the confidence intervals were very wide and the raised result may well have been due to chance (Table 19).

Table 19 Standardised[1] rates for incidence of all cancers, bowel cancer and prostate cancer for eligible security employees at the National Gallery. Standardised to Australian rates. Standardised incidence ratio and 95% confidence interval – by gender.

Cancer type	Gender	Expected[2]	Observed[3]	SIR[4]	95%CI[5]
All cancers	Females	3.4	5	1.45	0.47 – 3.40
All cancers	Males	12.0	14	1.17	0.64 – 1.96
All cancers	Persons	15.4	19	1.23	0.74 – 1.92
Bowel cancer	Females	0.3	1	*	*
Bowel cancer	Males	1.7	6	3.54	1.30 – 7.72
Bowel cancer	Persons	2.0	7	3.46	1.39 – 7.13
Prostate cancer	Males	2.2	4	1.82	0.50 – 4.65

1: Standardised by age and gender.

2: Number of cases expected.

3: Number of cases observed.

4: SIR = Standardised Incidence Ratio.

5: 95% CI = 95% confidence interval.

*: Too few cases to allow meaningful SIR to be calculated.

Assuming a five-year latency, the estimated rate for all cancers in security staff members was similar to the analysis without taking latency into account. The estimated rate for bowel cancer was lower but still two and a half times the Australian rate, but the low number of cases meant the confidence intervals were very wide. The estimated rate for prostate cancer remained high but the confidence intervals also remained very wide (Table 20). Similar results were found for the analysis using a ten-year latency, with a bowel cancer SIR for males of 3.8 (95% confidence interval 0.76 – 11.2), and bowel cancer SIR for persons of 4.2 (95% confidence interval 1.2 – 10.7).

Table 20 Standardised[1] rates for incidence of all cancers, bowel cancer and prostate cancer for eligible security employees at the National Gallery – assuming a five year latency. Standardised to Australian rates. Standardised incidence ratio and 95% confidence interval – by gender.

Cancer type	Gender	Expected[2]	Observed[3]	SIR[4]	95%CI[5]
All cancers	Females	2.7	5	1.82	0.58 – 4.27
All cancers	Males	9.8	10	1.02	0.49 – 1.88
All cancers	Persons	12.5	15	1.20	0.67 – 1.97
Bowel cancer	Females	0.3	1	*	*
Bowel cancer	Males	1.4	3	2.20	0.44 – 6.45
Bowel cancer	Persons	1.6	4	2.44	0.67 – 6.23
Prostate cancer	Males	1.9	4	2.15	0.59 – 5.48

1: Standardised by age and gender.

2: Number of cases expected.

3: Number of cases observed.

4: SIR = Standardised Incidence Ratio.

5: 95% CI = 95% confidence interval.

*: Too few cases to allow meaningful SIR to be calculated.

Analysis including possibly eligible cases

As mentioned, five cases occurred in persons for whom the date of employment was not known. Such cases are usually excluded from the sort of analyses presented here because they cannot be confirmed as being eligible for inclusion. However, it is helpful to repeat the analysis assuming that all cases were eligible to see if this would be likely to change the conclusions made from the analysis. Four of the relevant cancers were female breast cancers and the other was testicular cancer, so the all-cancer and female breast cancer analyses were repeated including these cases. The resulting SIR's for all cancers did not change much and remained just below one for all persons. The breast cancer SIR moved from 15% below one to 15% above one, but the confidence intervals suggested the difference from one could easily have occurred due to chance (Table 21).

Table 21 Revised-standardised[1] rates (including cases with no employment dates) for incidence of all cancers and female breast cancer for eligible employees at the National Gallery. Standardised to Australian rates. Standardised incidence ratio and 95% confidence interval – by gender.

Cancer type	Gender	Expected[2]	Observed[3]	SIR[4]	95%CI[5]
All cancers[6]	Females	38.5	33	0.86	0.59 – 1.20
All cancers[7]	Males	35.0	35	1.00	0.70 – 1.39
All cancers[8]	Persons	73.5	68	0.93	0.72 – 1.17
Breast cancer[9]	Females	13.0	15	1.15	0.65 – 1.90

1: Standardised by age and gender. Includes five cases with missing date of employment and so who may or may not have been eligible for inclusion.

2: Number of cases expected.

3: Number of cases observed.

4: SIR = Standardised Incidence Ratio.

5: 95% CI = 95% confidence interval.

6: Includes four cases with missing date of employment who may or may not have been eligible for inclusion.

7: Includes one case with missing date of employment who may or may not have been eligible for inclusion.

8: Includes five cases with missing date of employment who may or may not have been eligible for inclusion.

9: Includes four cases with missing date of employment who may or may not have been eligible for inclusion.

9.4 OCCUPATIONAL CAUSES OF MAIN IDENTIFIED CANCERS

This section provides a brief review of the known or suspected occupational causes of the main cancers identified in the Gallery employees.

Breast cancer

The main external causes of breast cancer appear to be ionising radiation, oral contraceptives and dietary factors, including alcohol. There are no occupational exposures that have been strongly and consistently implicated as causes of breast cancer. The only occupational exposure for which there is moderate evidence of increased risk is ionising radiation, although IARC has recently identified shiftwork as a probable cause of breast cancer[38-42].

Bowel cancer

The main risk factors for colon cancer are associated with diet, physical activity (low), alcohol intake (high), body mass index (high), chronic inflammatory bowel disease and other personal factors. The only occupational factor consistently associated with increased colon cancer is low physical activity, although a range of other exposures have been weakly suggested in some studies[43-55].

Lung cancer

The main occupational exposures associated with lung cancer are asbestos, arsenic, beryllium, cadmium, chromium VI, diesel exhaust, nickel, radon, silica, soots, bis-(chloro-methyl) ether and environmental tobacco smoke. All but diesel exhaust have been listed by IARC as definite human carcinogens causing lung cancer. Diesel exhaust is classified by IARC as a probable human carcinogen[22, 56-60].

Melanoma

Melanoma is a malignant disease of the melanin-containing cells of the skin. The only occupational exposure strongly implicated as increasing the risk of malignant melanoma is sunlight. However, the relationship is not straightforward, as there is some evidence that occupations that provide chronic sunlight exposure may provide protection from melanoma. There is also some evidence that artificial sources of ultraviolet light and polychlorinated biphenyls may increase the risk of melanoma. Other agents have been suggested, but the evidence for them is inconclusive[61-63].

Prostate cancer

There are no occupational exposures that have been strongly and consistently implicated as causes of prostate cancer. However, an association with pesticides and with low-activity occupations is suggested by published studies. There is also some evidence of an association with a range of other occupations and industries, although none that are present at the National Gallery[64-67].

10. DISCUSSION OF CANCER ANALYSIS

10.1 TYPES OF CANCER

There was nothing unusual about the types of cancer in Gallery staff members. The types of cancer were similar to those in the Australian population, with the five cancers with the highest numbers being the same in the Gallery employees as they were in the Australian population.

10.2 AGE AT DIAGNOSIS

Gallery employees tended to be younger when diagnosed with particular types of cancer than for the same cancer types in the general population. However, the cancers that were identified did not occur at an unusually young age. The younger age at diagnosis for the Gallery employees is probably because the study group had all been employed some time since the beginning of 1982 and had been followed for a maximum of 23 years. This means most of the study population would not have had the time to grow old – Table 9 shows that only 4% of the follow-up time was for current or ex-employees 65 years or older during the study period. In contrast, the Australian population used for comparison had no such limitation on age. Therefore, the younger mean age at diagnosis does not suggest there was something unusual about the cancers. It simply reflects the fact that the Gallery employees were generally younger than the Australian population to which they were being compared.

10.3 LATENCY

The period of time between starting work in the Gallery building and being diagnosed with cancer (the latency) ranged from four months to 23 years, with an average of 11.0 (s.d. = 6.1) years. Sixty per cent of cases had a latency of at least ten years. This is consistent with work in the Gallery having been a causative exposure for many of the cases (because the latency is ten years or more) but does not suggest that the Gallery exposures were responsible. It is also the pattern that would be expected if, as is common, people tend to stay in their job once they are in their 40s. With this employment pattern, persons can be expected to have worked for ten or more years before they reach the age-range in which cancer is much more common.

10.4 THE RATE OF CANCER

The analysis did not provide any strong evidence that the overall rate of cancer in Gallery employees was different to that of the Australian population, taking into account differences in age and gender. The point estimate (the value) for the SIR was less than one for all cancers combined, suggesting the rate was in fact lower in Gallery employees, but the confidence interval included one, which means there could easily have truly been no difference between the risk in Gallery workers and the risk in the general population. The point estimate for the SIRs for individual cancers varied with the different types of cancers that were analysed, some being higher and some being lower than the Australian rate. However, for all except bowel cancer in security officers (which is considered in the next section), the rates were consistent with the underlying rates being the same as the Australian population.

10.5 SECURITY OFFICERS

The point estimate for the rate of cancer in security officers was 23% higher than the rate for the Australian population, but the confidence intervals suggested the difference could easily have been due to chance. Taking into account latencies of five years and ten years gave a similar result. The only cancer types that occurred more than twice in security officers were bowel cancer (seven times) and prostate cancer (four times). The point estimate for both cancer types was raised compared to the Australian population, and for bowel cancer the rate for males and persons was between two and half and four times higher, depending on whether cancer latency was taken into account. The confidence intervals for the rates not taking latency into account and assuming a ten-year latency did not include one, suggesting on face value that the increase in rate may not have been due to chance and thus that the true underlying rate of bowel cancer may have been higher in Gallery security officers than in the general Australian population.

However, there are several issues that need to be taken into account when interpreting these results. As mentioned earlier, the standard statistical tests are likely to underestimate the confidence intervals and so over-emphasise the importance of any difference between an estimated rate and the comparison population rate. There are three main reasons for this. Firstly, the nature of a cluster investigation means that the study population has not been drawn randomly, as required by the underlying assumptions of the tests. This makes the standard statistical tests very difficult to interpret. Secondly, because multiple statistical tests have been undertaken, random factors can be expected to result in some rates being much higher, and some rates being much lower, than in the comparison population. That is, apparently important differences in the rates are commonly still due to chance. For example, the rates of

breast cancer, melanoma and all cancers combined appeared lower in the Gallery population than the Australian population. The rates of lung, bowel and prostate cancer appeared higher than the Australian population. In most situations this sort of variation reflects random variation rather than true differences in cancer risk in the populations. Thirdly, the rate of any particular type of cancer, and of cancer overall, will vary randomly over time and between different populations, even if the true underlying risk of developing cancer is similar. Lastly, cancers can be expected to have a considerable latency, and when latency was taken into account, the confidence intervals for the raised rate crossed one, suggesting the raised result may have been due to chance, although the confidence intervals were wide due to the low number of cases.

For these reasons, again as mentioned earlier, when trying to assess whether any cancer might be related to occupational exposures it is important not to rely simply, or even primarily, on the statistical testing, but also to consider other aspects of the cases. These aspects include the type of cancer, the age of onset of the cancer, the latency period involved, the length of exposure, the presence of exposures that might increase the risk of developing the cancer in question, and the presence of non-occupational risk factors for the cancer in question.

Evidence that is consistent with at least some of these cases in security officers being due to work-related exposures is as follows:

- The mean latency was 10.4 (s.d. = 6.5) years, and four of the seven cases had a latency of more than five years (although one of these was a case with very short exposure). So, if one or more Gallery exposures had increased the risk of developing bowel cancer, the latency for some of the cases was consistent with what is understood about how cancer develops and the latencies commonly involved.
- The mean length of employment as a security officer (and thus of "exposure" to work at the Gallery) for security officers who developed cancer was 9.4 (s.d = 6.8) years, with all but two of the seven cases employed for four years or more. So, the length of exposure at the Gallery was conceivably long enough to increase the risk of cancer if concerning exposures were present (even though what this exposure or exposures would be is not known).

Arguing against these cases of bowel cancer being related to occupational exposures at the Gallery are the following:

- Bowel cancer is a very common cancer in the Australian population – the second most common in the Australian population during the period covered by this study. So, this is not a rare cancer and would be expected to occur in people of the age and gender of those Gallery staff members who developed cancer.

- The average age at diagnosis of bowel cancer in the general population is 69.6 years, compared to an average age of 62.6 (s.d. = 4.3) years in security officers. Nearly a quarter of cases in the Australian population are diagnosed in people under the age of 60 years. So, the cases in Gallery security officers did not occur at an unusually young age.
- Three of the cancers were diagnosed less than five years after the person commenced work in the Gallery. Current understanding of cancer mechanisms means such a short latency period is very unlikely and therefore that the cancers would be unlikely to be related to exposures at the Gallery.
- One of the other cases occurred in a person who worked at the Gallery for three months, which is unlikely to be long enough for a work-related exposure to meaningfully increase the risk of developing cancer at a later time.
- Analyses excluding these four cases (which took into account the smaller at-risk period when latency was taken into account) produced raised rates of borderline statistical significance (the confidence interval almost crossed one).
- No exposures were identified at the Gallery, either currently or in the past, that have been found in the literature to be likely to increase the risk of developing bowel cancer.

Perhaps the most important consideration is that the most well-known, and the strongest, risk factors for bowel cancer are not related to work in any way. Information on these risk factors (e.g. diet, family history, physical activity, etc) was not known for the identified individuals, and follow-up of identified cases was not allowed as part of the ethics approvals obtained for the study. Such information is unlikely to have been obtainable anyway, as six of the seven affected persons have died, and there were not enough cases to allow such information to be easily interpretted. So, differences between security officers at the Gallery and the general Australian population in risk factors related to the individual are a likely explanation for the apparent higher rate of bowel cancer in security officers.

Low physical activity has been identified as a probable occupational risk factor for bowel cancer, but the security officers are not significantly less active at work than most Gallery staff and so this seems unlikely to be an explanation for any raised rate in security officers, especially since the rate in all staff was not raised.

In summary, it is difficult to determine whether the rate of bowel cancer in security officers employed at the Gallery was truly higher than the rate in the Australian population. Regardless, the characteristics of the cases, and the lack of evidence of any Gallery-related exposure that could increase the risk of developing bowel cancer, make it very unlikely that there is an increased risk of bowel cancer in security officers due to

exposures connected to their work at the Gallery. Any difference in bowel cancer rates are very likely to be due to personal risk factors rather than occupational exposures. Similarly, there is little to suggest there is any increased risk of other cancers in security officers due to exposures related to their work at the Gallery. Further investigation of this issue is unlikely to provide any more useful information.

10.6 Overall summary of the cancer analysis

The estimated rate for all cancers for all workers at the Gallery was 14% lower than the Australian rate, taking into account differences in age and gender. The estimated rate for some specific cancers was higher than the Australian rate, and for some cancers was lower than the Australian rate. The statistical tests that were conducted suggest that the differences in the rates (both the higher rates and the lower rates) could well be due to chance. In addition, these tests do not take into account the problems of statistical testing in cluster investigations. If they were able to do so, the statistical tests would provide even less evidence that the Gallery employees truly have a higher rate than the general population. The rate for bowel cancer in security officers was the only rate for which the confidence interval suggested there might be a true underlying difference compared to the Australian population. However, this is difficult to determine confidently because of the low number of cases and the problems inherent in interpreting statistical tests in a cluster investigation.

Therefore, the overall conclusion is similar to that just described for bowel cancers in security officers. There do not appear to have been any exposures at the Gallery that would be expected to have meaningfully increased the risk of developing cancer. Variations in the rates of specific cancers can be expected due to random factors, and the characteristics and rate of cancers identified in Gallery staff members are all consistent with those in the general community. Taking all this information into account, it is very unlikely that any of the cancers identified in Gallery staff members were related to exposures experienced while working in the Gallery building.

10.7 Methodological issues

Reasons for excluding some cases

Twenty-two people who had been Gallery employees at some stage and who had been diagnosed with cancer were excluded from the main analysis.

For seventeen of these people it is clear that they were not eligible to be cases. People who stopped working prior to the Gallery opening could obviously not have developed cancers at a later date due to work in the Gallery building. Similarly, cancers that developed prior to the person working in the building could not have developed due to exposures in the building.

People who developed cancer after the end of 2004 were not included in the analysis because the information available from the AIHW was only complete to the end of 2004. The analysis period could have been extended to, say, the end of 2006 to allow these later cases to be included. However, there would very likely have been other cases that occurred in ex-employees that would not have been known about and so could not have been included. This would mean the number of true cases would have been underestimated. The expected number of cases would not be so affected, and would increase because the follow-up time would be extended by two years. This would mean the ratio of Observed cases to Expected cases would be lower than it truly was and so the estimated Standardised Incidence Rate would be lower than it truly was.

The one group for whom there is considerable uncertainty are the five cases for whom the date of first employment was not known. These people could not be included in the main analysis because it was not known whether they ever worked during the study period and, if so, for how long and at what age; and it was not known whether the cancer was diagnosed after the person worked in the Gallery building. This means these persons might have been ineligible to be included cases, and if they were included the cancer rate would be overestimated. This is because the cancers might have occurred prior to exposure and so been ineligible, and because there would be extra cases in the Observed, yet these people would not have contributed time at risk to the calculation of the expected number of cases. However, equally, they might have been eligible, which would mean their omission would underestimate the cancer rate. In a worst case, all five cases would have been eligible. Therefore, the analysis was repeated assuming all five cases (four of breast cancer) were eligible. These analyses did not alter the overall conclusions and so the analysis in which all cases are known to be valid was preferred for presentation in this report.

Effect of excluding some current staff due to lack of consent

One hundred and thirty staff members (44.5% of the 292 current staff and 6.1% of all 2,112 staff) did not give permission for their details to be provided to the AIHW so that their names could be matched to the NCSCH data. The vast majority of these people did not refuse permission – they just didn't return their consent forms. Only eight people returned their consent forms refusing permission to be involved in the study. None of these people were included in the number of Observed cases (because even if they had

developed cancer the NCSCH matching would not have identified them since their names were not sent to the AIHW). Therefore, they could not be included in the at-risk calculations to estimate the number of Expected cases. Otherwise there would potentially have been an underestimation of the ratio of Observed cases to Expected cases and thus a potential to miss an elevated cancer rate.

It seems unlikely that many, perhaps any, of the staff who did not provide permission had ever been diagnosed with cancer. People who had been diagnosed with cancer after they commenced work in the Gallery building are likely to have been very interested in the study and likely to have wanted to be involved. The study team went to great lengths to ensure staff that any information supplied would be kept confidential and this appeared to have been accepted by the staff. It was therefore unlikely that staff members perceived a disincentive to be involved. Of the eight people who refused permission, two provided reasons – one had only worked for a short amount of time and felt participation was not appropriate, and the other felt there was insufficient information supplied and insufficient justification for the study. Therefore, it seems likely that the missing current staff meant that the Expected number of cases was under-estimated but that the Observed number of cases was correct.

Of the 130 current staff who were excluded because of lack of consent, 77 (59.2%) would have been eligible for inclusion in the study because they worked for at least some time in the study period (1/1/1982 to 31/12/2004 inclusive). They represented a total of 537 person-years of follow-up, only 2.4% of the 22,306 person-years of follow-up that was included in the analysis. This means that the underestimation of the Expected cases from this source of uncertainty should have been very minor.

In summary, it seems likely that the necessary omission of current staff who did not provide consent to be included would not have meaningfully affected the results.

Effect of excluding some staff due to missing data

Information was available for 127 persons who were rightly excluded because they either finished work too early or started work too late to be included. The exclusion of these persons would not have introduced any problems to the analysis. One hundred and sixty-eight other employees (all previous employees) were excluded from the analysis due to missing data. These 168 were potentially eligible but were missing information on the date of starting work (151 persons) or the date of birth (17 persons), both of which were necessary for them to be included in the analysis. Their names were sent to the NCSCH, and indeed five of them were identified as having cancer. These five cases were not included in the observed number of cases used in the main analysis, but inclusion in a specific extra analysis showed that their inclusion made little difference to the results

(as described above). The 168 excluded persons represent about 10% of the final total of persons who were included. Most of them are likely to have been eligible for inclusion, and their exclusion will have led to the under-estimation of the time at risk in the population, and therefore the underestimation of the Expected number of cases, which would lead to an over-estimation of the SIR. It is likely that the persons with missing employment information did not work for very long, as otherwise their employment information would probably have been available, and so the missing time at risk due to the exclusion of these people is not likely to have been large. Therefore, although the extent of the overestimation of the SIRs cannot be determined exactly, it is not likely to have been large enough to significantly alter the conclusions drawn from the results.

Exposures that occurred prior to moving into the building

The analysis was based on the assumption that work in the Gallery Building was the potential source of increased cancer risk for Gallery employees. This means it does not provide information on the possibility of increased risks arising from exposures of Gallery staff members that occurred before the Gallery building was occupied towards the end of 1981. It was not possible to properly examine the effect of exposures that occurred prior to working in the building because the NCSCH only provided information on cancers diagnosed since the beginning of 1982. Also, it was likely that some of the employment information for these people related to first employment in other positions in the public service rather than employment in Gallery-related work, making it very difficult to know when "exposure" (i.e. the at-risk period) should be deemed to have started. About 8% (175 / 2,112) of the initial 2,112 subjects started work prior to the 1/1/1982, and 17 of the original 78 persons diagnosed with cancer at some point started work prior to 1/1/1982 (seven of these were not included in the final analysis because they finished work prior to 1/1/1982). The exposure assessment did attempt to consider exposures prior to the opening of the Gallery, although information was limited. The only suggestion of worrying exposures involved Conservation staff when they were delivering and picking up items to be cleaned or fumigated, and even in those circumstances the likely exposures appeared to be much too low to be of concern. In addition, there was only one case of cancer diagnosed in a person who had worked in Conservation at any time. In summary, it is unlikely that prior to staff members beginning work in the Gallery building there were any sources of work-related exposure that would have increased the risk of Gallery staff members developing cancer.

Study period

The study period was 1/1/1982 to 31/12/2004 inclusive. This period could not have started earlier because the cancer registry data did not cover that period, meaning that cancers could not have been identified comprehensively. The period could not be extended beyond 31/12/2004 because that was the most recent date to which the cancer registry information was complete at the time the data were supplied by the AIHW. More

recent data will become available over time (e.g. data for 2005 should be available early in 2009), but there is no reason to think that extending the period of analysis will provide information that would change the conclusions of the study. The study period covers 23 years, certainly enough time for cancers due to exposures at the Gallery up to about 1990 to have developed enough to be diagnosed. Cancers due to exposures at the Gallery since about 1990 would still have had time to occur, but the shorter period between exposure and the end of the study period means that it is possible that some cancers due to more recent exposures would not have had time to have been diagnosed by the end of 2004. However, there is no evidence at all that potentially carcinogenic exposures at the Gallery have worsened over time. In fact, all evidence suggests such exposures have never been high, and have been minimal in recent years. There is nothing in the analysis that suggests a higher risk of cancer in people who have worked in the Gallery in more recent years. In summary, the study period can be expected to have been suitable to answer the questions that the study was designed to answer. There does not appear to be any benefit in repeating the analysis at a later time to allow the inclusion of more recent cases.

Latency

The correct latency to use in cancer risk analyses is usually not known. Most cancers are likely to have a latency of a minimum of five or ten years, although in an individual case this can not be known for certain. The usual approach is to conduct the analysis assuming no latency, and then to repeat it assuming a range of latencies depending on the number of cases available for analysis assuming various latencies. This is the approach that was taken in the analysis presented here. There were enough cases to allow separate analyses using latencies of five years and ten years. These analyses did not materially alter the conclusions based on the analysis not taking latency into account, and for ease of explanation it is the non-latency analysis that is used as the basis for the main presentation of results.

Multiple jobs

Fourteen staff members were recorded as having had two periods of employment at the Gallery. Eight of these people were current staff members who did not return their consent forms and so could not be included in the study. Four were current staff members who had been employed previously and two were ex-employees. For each person, the first period of employment was used in the analysis. Omitting the second period of employment would have made no difference to the cancer rate analysis results, as the follow-up period commenced from the time of first employment, regardless of how long that employment lasted. It would have made trivial difference to other results, as there were so few people involved; the second employment period started after the end of 2004 for most; and the date of termination for the first job was missing for the others, so it was assumed the person was still employed at the end of the study period.

Implications for volunteers and visitors

The Gallery has a large number of volunteers who have worked in the building since it opened. There are also thousands of members of the general public who visit the Gallery each week. These people are potentially exposed to some of the exposures of the Gallery staff members.

Volunteers were not included in the analysis because the documentation on the working period and personal details of the volunteers was not considered complete enough to allow them to be included in the analysis. This should not have had any effect on the conclusions based on the analysis because the relevant cancers were not included in the estimation of Observed cases and the time at risk for volunteers was not included in the calculation of the Expected number of cases. In addition, including volunteers would have made it more difficult to identify any effect that may have been present because volunteers would have had less exposure than employees to anything in the Gallery, meaning that if they were included the apparent risk for employees would have been less than it really was. Since volunteers can be expected to have less exposure than employees to anything in the Gallery, if it is concluded that there is no problem for Gallery employees this would also be the case for volunteers. This argument also holds for members of the public.

In summary, no error would be have been introduced by excluding volunteers, and the findings of the study should apply to volunteers and members of the public as well as to Gallery employees.

10.8 OTHER LIMITATIONS OF THE FINDINGS ON CANCER

Most of the limitations in the analysis of cancer rates presented in this report have been considered in the previous section. The main potential sources of error in the study were not identifying all the relevant cases of cancer and not calculating the correct number of Expected cases. The approach used to identify the cancer cases was as comprehensive as possible and is considered likely to have identified virtually all eligible cases. Analyses including and excluding cases of uncertain eligibility produced similar results. The approach used to calculate the time at risk relied on the information supplied by the Gallery. Much of this information on past employees had to be transcribed from microfiche records and so some error can be expected. However, there were few inconsistencies in the recorded data, suggesting the transcription was accurate and unlikely to have affected the results to any important degree. Rates of cancer for the whole of Australia were used to calculate the Expected number of cases. This was because Gallery staff members who moved away from Canberra could easily have moved

to various parts of Australia. Nevertheless, most of the previous staff members are likely to have remained in the Australian Capital Territory or New South Wales, so it could be argued that using cancer rates from these jurisdictions may have been more appropriate. Since the rates of cancer are similar across Australia, this would not have led to any important error in the results.

11. OTHER ASPECTS OF OCCUPATIONAL HEALTH AND SAFETY

As mentioned earlier, the Gallery has a long history of criticisms of occupational health and safety, dating back to the 1980s. This study focused on the possibility of a cancer cluster being present in current and former Gallery staff members. Aspects of occupational health and safety that were not relevant to this consideration did not fall within the scope of the study and are not directly addressed in this report. This is likely to mean that some occupational health and safety issues of concern to one or more current or former staff members will not be addressed.

There are some aspects of occupational health and safety that are not relevant to the consideration of cancer risk that were nevertheless included in the project. These are the issues included in the list of questions about various occupational health and safety concerns submitted by Gallery staff members in 2005. The Gallery management undertook to provide answers to these questions and have been collecting relevant information to allow this to be done. In addition, some of these questions have already been answered by the findings of this study. This information is provided in Appendix 5, along with responses to those other questions that can be answered. Some questions are not answered, either because the necessary information is not available and/or the question is beyond the scope of the current project.

12. RECOMMENDATIONS

12.1 RECOMMENDATIONS ON EXPOSURE

Recommendations arising from the first stage of this investigation were presented in the Stage One report and are repeated here. They are also presented in the relevant sections of the current report. Some of these are on-going and some were specific to the time when they were made. Those recommendations that required specific interventions were acted upon by the Gallery soon after the release of the Stage One report. The response of The Gallery to these recommendations, as reported by the Gallery in April 2007, is included in italics next to the heading "Action" for each of the recommendations. Some actions took longer to implement and the Gallery provided further information on these areas at a later time. This information is also included in the "Action" sections as appropriate.

Asbestos

Follow the recommendations of the January 2007 asbestos management plan, including referring to the relevant procedures when new or maintenance work is being undertaken and labelling asbestos-containing material.

Action: *Completed labelling of asbestos in the building and will continue to follow the Asbestos Management Plan.*

Cadmium, carbon black, cobalt, magenta

Arrange glass containers on the shelf such that they cannot be knocked over and the labels are more easily read.

Action: *Suitable containers have been obtained, labelled and arranged as was recommended. This work has since been reviewed by Dr. Driscoll and Mr Foster.*

Continue using a fume cupboard when decanting bulk pigment powders.

Action: *We have developed a standard work procedure to ensure this continues.*

Formaldehyde

Ensure that MDF panels in exhibits are sealed. If irritation occurs, a respirator designed for formaldehyde exposure should be used. Advice on this should be sought from respirator suppliers. Dust particulate masks, Class P1, should adequately reduce exposure to dust from MDF but not necessarily to formaldehyde vapour. These masks will reduce exposure to formaldehyde which is adsorbed onto dust particles.

Security guards entering construction areas when airborne MDF dust may be present (e.g. during sawing operations) should also wear an appropriate dust particulate mask whilst in the construction area.

Action: *The Gallery will continue to strictly enforce its standard work procedure to address the cutting of MDF. Contractors currently use an appropriate respirator when working with MDF, and the Gallery will make available appropriate masks for any NGA staff, should they require one.*
Raw MDF is sealed with paint on its external surface when used in exhibits.

Wood dust

Continue to wear P1 dust respirator when likely to be exposed to wood dust.

Action: *This practice will continue for staff and contractors.*

Diesel fumes

Formal measurements should be made of current exposures to diesel particulate.

Action: *Arrangements have been made to measure diesel particulates on Thursday 29 March 2007. (Two sets of measurements were subsequently undertaken and the reports of these measurements were later made available to the study team. Both reports identified minimal levels of diesel particulate (as measured by elemental carbon) but both noted that the levels would be likely to be somewhat higher if trucks were allowed to have their motors idling while they were in the loading bay.).*

The loading dock should be designed so that it is isolated from areas occupied by staff once the new extension and renovation of the building are completed. Alternatively, exhaust ventilation could be fitted to the loading dock to capture the exhaust fumes.

Action: *The new building works will address this issue. (The Gallery subsequently provided further information: "The new extensions will include separate art and general goods loading docks. The new arts loading dock has been completed and commissioned. The dock is separated from the rest of the building by a sealed door. The dock has a dedicated exhaust ventilation system. The new general goods dock will have similar arrangements.".)*

Diesel fumes (continued)

Some form of exhaust ventilation appears to be warranted as an interim measure while the new extension is being planned and built. The practicalities of installing such ventilation as a short-term measure in the current building should be investigated by the Gallery.

Action: *The Gallery has instigated a control measure where diesel fumes exposure is limited by ensuring all engines are turned off while vehicles are in the loading dock. The Gallery Engineering Consultant is evaluating possible short-term ventilation options for consideration. (The Gallery subsequently provided further information: "A cost proposal was received, and because of the proposed changes to the loading dock it was not considered to be cost effective to make interim changes. The Gallery wrote to all its suppliers requesting they advise their drivers to switch off their engines while in the loading dock. Signs advising this were also installed. Security staff were requested to be vigilant in ensuring that all drivers observed this requirement.".)*

In addition, it would be appropriate to formally inform (in writing) all delivery drivers and contractors of the importance of turning off their truck engines when stopped in the loading dock. This requirement should be rigorously enforced by Gallery staff members responsible for receiving or sending goods via the delivery and loading docks.

Action: *Gallery security staff have been asked to vigorously enforce this matter to ensure that engines are not left running while vehicles are in the loading dock. The Gallery has sent letters to its suppliers informing them of this important OH&S issue and asking them to help us limit diesel fume exposure.*

Extremely low-frequency electro-magnetic fields

Routine monitoring of electromagnetic fields is probably not warranted. However, it would be wise to repeat the measurements in and around the security control room any time there is a significant change in electrical equipment in the security control room.

Action: *This practice will be adopted.*

Risk assessment

Complete the inventory of hazardous substances.

Action: *A hazardous substances inventory has been completed, and is being reviewed. (The Gallery subsequently provided further information: "A hazardous substances inventory has been completed, and reviewed. All substances identified were included in the Gallery's Hazardous Substance manifest.".)*

Complete and maintain the risk assessment of hazardous substances and exposures, including comprehensive documentation of MSDSs, worker training, record keeping, and proper labelling, storage and disposal.

Action: *The identified actions are to be undertaken as soon as possible. (The Gallery subsequently provided further information: "The risk assessment of hazardous substances is continuing. A number of staff were trained in the use of the CHEMWATCH database in 2007, and this should assist the Gallery to manage hazardous substances.".)*

12.2 FINAL RECOMMENDATIONS

Dissemination of the study findings

The final report of the study should be made available to the past and present employees and the general public. This is probably best achieved by placing a copy on the Gallery web site and writing to past employees informing them of the completion of the study and the whereabouts of the report.

Further investigations

No further investigation of the concern regarding work-related cancer at the National Gallery of Australia is considered necessary. Any subsequent concerns about this or other occupational health and safety issues amongst Gallery staff members should be responded to promptly and comprehensively.

13. CONCLUSIONS

This investigation into a possible cluster of cancers at the National Gallery of Australia identified a number of potential exposures to definite or suspected carcinogens. From the available evidence, none of these exposures seem likely to have been high enough to have meaningfully increased the risk of Gallery staff members, volunteers or members of the public, developing cancer. All now seem well controlled.

There is no strong evidence that the rate of cancer in Gallery employees is different to the rate of cancer in all Australians, and the characteristics and rate of cancers identified in Gallery staff members are nearly all consistent with those in the general community. The evidence suggests any difference present is due to chance. The one possible exception is the rate of bowel cancer in security officers, which may have truly been higher than the rate in the general Australian community, but there is little to suggest such an increased rate might be due to exposures at the Gallery.

Taking all this information into account, it is very unlikely that any of the cancers identified in Gallery staff members were related to exposures experienced while working in the Gallery building.

No further investigation of this issue is considered necessary.

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APPENDIX 1: LIST OF GALLERY REPORTS CONSIDERED DURING THE INVESTIGATION

Author	Year	Month	Title
Unknown	Unknown		Ode: Costume for a constellation [extract from the Gallery catalogue – obtained 16 February 2007]
Rogers	1985	May	Re: Health hazard from Nuralite roof membrane [National Occupational Health and Safety Commission report]
Andrews	1985	June	Australian National Gallery – presence of asbestos based material on the ANG roof [letter to Department of Housing and Construction]
Administrative Services Manager	1985	June	Materials used on the ANG roof [memo to all staff]
Edwards, Madigan, Torzillo, Briggs	1988	September	Australian National gallery roof investigation. September 1998. For the National Capital Development Commission
Aquatech P/L	1990	February & March	Legionella analysis
Munn	1990	May	Re-roofing of the Gallery Building [memo to section heads]
Versey	1990	June	Faxed copy of Australian National University report on air sampling results and the air monitoring program prepared by the ACT Government Analytical Laboratory
Dorham	1990	June	Faxed copy of notes of site meeting held on 28 June 1990
Durham	1990	July	Minutes of 16 July 1990 meeting of the "committee constituted to monitor, execute and communicate matters pertaining to the Gallery's current re-roofing program" [memo to Betty Churcher and Kevin Munn]-
Asset Services	1993	January	Cooling Tower Water Quality
Pomeroy	1993	February	Report of environmental monitoring at selected locations in the ANG including formaldehyde & ozone
Asset Services	1993	May	Testing of Cooling Tower Sludge
MPL Laboratories	1994-1995	Various	NGA Cooling Tower Water Analysis
Altree-Williams	1995	May	Preliminary Evaluation of Indoor Contaminants at the NGA. Survey of indoor air contaminants including formaldehyde, VOCs, CO_2, particulates (ANUTECH)
Moon	1995	September	Security incident report
Honeywell	1995	October	National Gallery of Australia. Life cycle costing report
Marsh	1995	October	Report on visit to National Gallery of Australia - Canberra
Barratt & Smith Water Testing	1995-1996	Various	NGA Cooling Tower Water Analysis

Author	Year	Month	Title
Sonic Healthcare Ltd	1996	February & May	NGA Cooling Tower Water analysis
Coopers and Lybrand	1996	April	National Gallery of Australia. Strategic plan for asset replacement and maintenance
MPL	1996	September	Air Monitoring at NGA
Maguire	1997	March	Report of planned workplace investigation. The National Gallery of Australia at Parkes ACT 1/4 October 1996. To assess compliance with the *Occupational Health and Safety (Commonwealth Employment) Act 1991*.
Halliday	1999	May	CSIRO Entomology
Bligh, Voller, Nield	1999	May	National Gallery of Australia. Building audit
Robson	1999	January	Airborne Dust Monitoring at the NGA (939dust)
Maguire	1999	July	Report of Investigation. National Gallery of Australia at Parkes, ACT. Revisit following a planned investigation. 1/4 October 1996. To assess compliance with the *Occupational Health and Safety (Commonwealth Employment) Act 1991*.
Robson	1999	December	Analysis of air handling plant cooling water and scale samples APH 7.
Broadbent	2000		NGA air conditioning (consultant report for Maguire, 2000)
Creaser	2000		Report of reactive workplace investigation (Comcare 1997)
Pugsley	2000		Asbestos Removal in the Fitter's Workshop July 2000
Robson	2000	January	Analysis of air handling plant cooling water and scale samples Plant area AHP – 7 NGA (1133)
Maguire	2000	February	NGA air conditioning (Comcare 1913)
Robson	2000	July	NGA – Analysis of fire panel core sheet for asbestos content
Hennessy	2000	October	Investigation of issues related to the operation and maintenance of the air conditioning systems at the Australian National Gallery of Australia – Canberra ACT (AHA Management Pty Ltd)
Bennett	2001	August	*Occupational Health and Safety (Commonwealth Employment) Act 1991*. Report of an investigation – subsection 41(3). Health and safety policies and practices (OHS management systems). National Gallery of Australia.
Trevanion	2001	August	Report of an investigation under Section 41 of the OHS(CE) Act. [The investigation dealt with a fall that had occurred in the riser, which provides vertical access between levels of the building and has building infrastructure like air conditioning duct work and other utilities (water, electricity, pipe work) running through it.] (Comcare 2282)
Robson	2001	August	Testing to assess whether fibrous AHU1 internal duct insulation was detectable within Galleries 1 & 2 (1442SMFprocedure)

Author	Year	Month	Title
Trevanion	2001	October	Report of an investigation under Section 41 of the OHS(CE) Act. [Investigation into "…water on the floor in some of the air handling units (AHUs) at the NGA and that this was causing hazards, in particular there was concerns that the water may come into contact with electrical wiring and pose a risk of electrocution for any persons in the AHUs.".]
Grills	2001	December	Report of an investigation by Quality Management Solutions on behalf of the Australian National Gallery into allegations by Mr Jason Robinson relating to the actions of Mr Tava Situati.
Trevanion	2001	December	Report of an investigation conducted under the *Occupational Health and Safety (Commonwealth Employment) Act 1991*: concerns that asbestos may be present on a control panel outside air handling unit 1, National Gallery of Australia, Canberra (NGA) (Comcare 2386)
Lark	2002	March	Cancer cases at the NGA (Health Services Australia (HSA))
Trevanion	2002	March	Report of investigation under section 41 of the *Occupational Health and Safety (Commonwealth Employment) Act 1991* ("OHS (CE) Act") into possible contravention of s76. National Gallery of Australia (NGA) Parkes Place Parkes (Comcare 2378)
Lark	2002	April	Cancer cases at the NGA (Health Services Australia (HSA))
Robson	2002	May	NGA - Indoor Air Quality Assessment Security Office (1594iaq)
Robson	2002	May	NGA - Security control room electromagnetic field assessment
Robson	2002	June	Exposure Risk Assessment- Toluene (1627toluene)
Robson	2002	July	NGA – Risk Assessment of materials to be used during Ramp Replacement Works (1627flooringMSDS)
Dingle & Cheong (Murdoch)	2002	September	Indoor Fungal Investigation of Employee Occupied Areas of the NGA Building, Canberra, ACT
Robson	2002	September	NGA – Risk Assessment and Cleanup Procedure for Synthetic Mineral Fibre (1762riskassess)
Robson	2002	October	NGA – Indoor Air Quality Assessment (1689Iaq)
Wray	2003		Report to assess compliance with recommendations of investigations 1913 and 1997 (Comcare 2372)
Hogan	2003		Medium Density Fibreboard Dust Incident – Temporary Exhibition Gallery
Robson	2003	January	Aldehyde. Carbon Monoxide, Carbon Dioxide & EMF Testing NGA (1739iaq)
Robson	2003	February	NGA – Airborne Particulates Monitoring (1762particulates)
Robson	2003	February	NGA – Cleanup Procedure and Risk Assessment for Synthetic Mineral Fibre (1762riskassess)
Robson	2003	February	NGA – Airborne fibre clearance monitoring following cleanup of Synthetic Mineral Fibre (1762SMF)
Robson	2003	February	NGA – Airborne fibre clearance monitoring following cleanup of Synthetic Mineral Fibre (1762SMF1)
Robson	2003	February	NGA – Airborne fibre clearance monitoring following cleanup of Synthetic Mineral Fibre (1762SMF070203)
Robson	2003	February	NGA – Airborne fibre clearance monitoring following cleanup of Synthetic Mineral Fibre (1762SMF080203)

Author	Year	Month	Title
ACT Government Analytical Laboratory	2003	March	Analysis of particulate matter from library air conditioning duct NGA (F03/0024)
ACT Government Analytical Laboratory	2003	March	Interim Report on dust sample analysis from NGA (F03/0025)
ACT Government Analytical Laboratory	2003	March	Interim Report on particulate sampling from NGA (F03/0027)
Hogan	2003	June	Comcare investigation into an incident with dust from MDF
Robson	2003	August	Analysis of particulate matter to Level 8 Public Affairs Office and Marketing Manager's Office workstations (1942part)
Robson	2003	November	NGA – Analysis of insulation sample for asbestos content (2011AHU3insulation)
Robson	2003	November	NGA – Airborne fibre monitoring during removal of Synthetic Mineral Fibre from Air Handling Unit(AHU3)ducting (2020SMF061103)
Robson	2003	November	9 John's Pl Hume – Airborne fibre monitoring associated with spillage of Synthetic Mineral Fibre from air conditioning ducting (2021SMF07-0811-3)
Robson	2003	November	Airborne fibre monitoring undertaken during cleaning of Library books and shelving at 9 John's Pl Hume (2021SMF121103)
Robson	2003	November	Airborne fibre monitoring undertaken during cleaning of air conditioning ducts to Gallery 5 (2025SMF181103)
Robson	2003	November	NGA – Assessment of internal duct insulation sample for asbestos content (2025Gallery5insulationNATAReport)
Robson	2003	November	NGA 6 - Respirable particulates sampling (2025partassessNov1903)
Robson	2003	December	Airborne fibre monitoring to assess fibre levels in Curator's Row area Lower Ground Floor (2025SMF_03_12_03)
Ford	2004		Letter to Health Services Australia (8/10/2004)
Trevanion	2004		NGA glass wool fibres in galleries and work areas (Comcare 2553)
Robson	2004	January	NGA – Investigation of insulation material for microbial contamination (2077debrisanalysis)
Robson	2004	February	Airborne fibre monitoring undertaken during cleaning of air conditioning ducts to Gallery 9 (2092SMF050204)
Robson	2004	March	Material Analysis & Airborne fibre monitoring to assess synthetic mineral fibre levels (2115SMF)
Robson	2004	April	Material Analysis to determine composition of fine white powder NGA (2131powderSummary)

Author	Year	Month	Title
Robson	2004	May	NGA Basement Pump Room – Procedure to remove asbestos rope lagging to hot water pipe penetrations (2166method150504)
Robson	2004	July	Sample collected from the NGA (2183DebrisReport)
Robson	2004	September	Assessment of mould contamination at NGA (2268Mould)
Hogan and Trevanion	2005		Investigation of substance falling from ducts in the workshop (Comcare xxx)
Wray	2005		Assessment of documents relating to the National Gallery of Australia (Comcare 2988)
Hogan	2005	February	Report of Investigation No 2693, Cellulose in Workshop Ductwork
Robson	2005	March	Aerobiology Assessment of NGA February 2005 (2379_FungiRep_Feb05)
Robson	2005	May	NGA – Analysis of provided dust sample for asbestos content (2647AsblD)
Hogan and Trevanion	2005	June	Asbestos contamination of the workshop at the NGA (Comcare 2617)
Robson	2005	July	Investigation of mould, concrete dust, general dust, drinking water, microwave radiation, magnetic field exposure
Unknown	2005	August	Wall Collapse Incident in Temporary Exhibition Gallery (Comcare 2939)
Hennessy	2005	September	Re: inspection of air conditioning works [letter and update on summary of recommendations
James Venn and Associates	2005	October	National Gallery of Australia. Electrical incident 14 September 2005
Howard	2006	May	Using X-ray equipment [NGA standard working procedure (SWP) #13]
Nancarrow (ERM Pty Ltd)	2006	June	Gas monitoring / characterisation pre gas phase filter system implementation – air handling unit No. 2 (Report No. S2738 - Environmental Risk Management Australia, Pty Ltd)
Robson	2006	October	Monitoring of areas adjacent delivery dock for carbon monoxide (3323_IAQ_CO_REPORT_20061024)
Robson	2006	November	Quote for monitoring of Diesel Particulate matter (DPM) to National Gallery loading dock
Robson	2007	January	Asbestos Management Plan. National Gallery of Australia. Parkes Place. Parkes ACT. January 2007
Robson	2007	April	Assessment Of Vehicle Emissions To Loading Bay and Security, National Gallery of Australia
Robson	2007	July	June 2007 assessment of diesel particulate emissions to loading bay and security areas, National Gallery of Australia

APPENDIX 2: IARC AND NOHSC CLASSIFICATIONS OF CARCINOGENICITY

IARC CLASSIFICATION OF CARCINOGENS

The following information is taken from the IARC web site describing the IARC classification (http://monographs.iarc.fr/ENG/Classification/index.php).

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

NOHSC CLASSIFICATION OF CARCINOGENS

The following information is taken from the NOHSC Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment[12].

Category 1
Established human carcinogens are those substances known to be carcinogenic to humans. There is sufficient evidence to establish a causal association between human exposure to these substances and the development of cancer.

Under the circumstances where substitution of less hazardous materials is technically not feasible, the use of these carcinogenic substances should be controlled to the highest practicable standard by the application of effective engineering control techniques and, where necessary, complemented by the use of appropriate personal protective equipment.

Category 2
Probable human carcinogens are those substances for which there is sufficient evidence to provide a strong presumption that human exposure might result in the development of cancer. This evidence is generally based on appropriate long term animal studies, limited epidemiological evidence or other relevant information.

These substances should be treated as if they are carcinogenic to humans. Under the circumstances where substitution of less hazardous materials is not possible, exposures to these substances should be minimised to the lowest practicable levels. This should be achieved by the application of effective engineering control measures, revised work practices and, where necessary, complemented by the use of appropriate personal protective equipment.

Category 3

Substances suspected of having carcinogenic potential are those substances which have possible carcinogenic effects on humans but in respect of which the available information is not adequate for making a satisfactory assessment. There is some evidence from appropriate animal or epidemiological studies, but this is insufficient to place the substance in Category 2.

APPENDIX 3: IARC AND NOHSC CLASSIFICATION OF, AND NOHSC EXPOSURE STANDARD FOR, THE MAIN EXPOSURES CONSIDERED IN THIS REPORT

Exposure	IARC classification	NOHSC classification	NOHSC exposure standard[1]
Asbestos	Group 1	Category 1	0.1 fibre/ml – 1.0 fibre/ml
Benzene	Group 1	Category 1	5 ppm
Cadmium	Group 1	Category 2	0.01 mg/m^3
Environmental tobacco smoke	Group 1	Not classified	-
Ethylene oxide	Group 1	Category 2	1 ppm
Formaldehyde	Group 1	Category 1	1 ppm
Radium	Group 1	Not classified	-
Wood dust (other than MDF)	Group 1	Not classified	1 mg/m^3
X-rays	Group 1	Not classified	-
Diesel fumes	Group 2A	Not classified	-
Epichlorohydrin	Group 2A	Category 2	2 ppm
Polycyclic aromatic hydrocarbons (PAHs)	Group 2A	Not classified	-
Tetrachloroethylene	Group 2A	Category 3	50 ppm
Carbon black	Group 2B	Not classified	3 mg/m^3
Carbon tetrachloride	Group 2B	Category 2	5 ppm
Cobalt	Group 2B	Not classified	-
Dichloromethane	Group 2B	Category 3	50 ppm
Dichlorvos	Group 2B	Not classified	0.1 ppm
Extremely low-frequency electro-magnetic fields	Group 2B	Not classified	-
Magenta	Group 2B	Not classified	-
Potassium bromate	Group 2B	Not classified	-
Synthetic mineral fibre	Group 2B	Not classified	0.5 fibre/ml
Welding fumes	Group 2B	Not classified	5 mg/m^3
Methyl bromide	Group 3	Not classified	5 ppm
Trichloroethane	Group 3	Category 3	125 ppm
Hydrogen peroxide	Group 3	Not classified	1 ppm
Isothiazolone compounds	Group 3	Not classified	-

1: 8-hour Time-Weighted Average

APPENDIX 4: DETAILED SUMMARY OF SELECTED PAST HAZARD SURVEY REPORTS

1 ASBESTOS

Hogan & Trevanion, Asbestos incident in workshop, July 2000 (Report June 2005)

Concerns were raised on 13 July 2003 about an incident that occurred in the NGA's workshop on 13 July 2000. This incident involved a contractor cutting into a fire panel containing asbestos, using a jigsaw, during the process of installing an extension to a dust extraction system in the wall above a storeroom door located in the workshop. This workshop includes a fitter's workshop, a storeroom located off the fitter's workshop and a carpenters' and painters' workshop. Particular concerns were that NGA staff had undertaken cleaning of the site following the incident on 13 July 2000 and that one or more workshop vacuum cleaners were used in a further clean up of the incident site on 15 July 2000. Several NGA employees were in the vicinity of the incident site at varying times on 13 July 2000, but only one workshop employee witnessed the asbestos incident.

The fire panel content was analysed by **Robson Laboratories** on 13th July 2000 and the panel was found to contain chrysotile and amosite forms of asbestos.

The incident was investigated by Comcare in 2001 and in 2003. The 2001 investigation concluded that the matter had been dealt with appropriately by the NGA. The second Comcare investigation was undertaken between July 2003 and March 2005 (see Hogan and Trevanion, 2005) and did identify issues of concern. However, it found there was no substantive evidence to indicate that NGA staff undertook a clean up of the incident site on 13 July 2000. The areas were sealed off and cleaning was done by **TT Asbestos Removals** on 13 July and 15 July 2000. No evidence was found that workshop vacuum cleaners were used to clean up asbestos

Monitoring of airborne asbestos fibres was done on 13 and 15 July 2000 **(Robson)** after clean up of metal and carpentry workshops following the asbestos spillage in the metal workshop area. Monitoring was done in the electrical storeroom, metal workshop and carpentry workshop. All results were below the Minimum Practical Detection Limit of 0.01 fibres / ml.

Some cleaning in the carpenters' workshop was done by a NGA employee using a non-workshop vacuum cleaner with HEPA filter on 15 July 2000. No PPE was used by this employee due to the results of air monitoring on 13 July 2000 (Robson) not showing any

fibres above the detection limit of the method used. The bag and filter were removed from the vacuum cleaner used and given to TT Asbestos removals for disposal.

Surface testing as arranged as part of the second Comcare investigation. This testing was undertaken on 1 Oct 2003 and found two amosite fibres in a sample taken from the window sill in the storeroom located off the fitter's workshop. The area was sealed off and the fitter's workshop and storeroom were cleaned by ACT Asbestos Removals on 2 and 9 October 2003.

Air monitoring and surface testing was conducted on 2, 3, 7, 13, 15 and 20 Oct 2003 across various areas of the Gallery workshop. No further asbestos fibres were found.

Monitoring of airborne fibres was done on 21 Nov 2003 in the carpentry and metal workshop area. All results were below the Minimum Practical Detection Limit for airborne fibres of 0.01 fibres / ml. The two NGA vacuum cleaners used during the clean up on 13 July 2000 were disposed of and replaced with two new ones on 17 Oct 2003.

Robson, Dec 2001, Asbestos

Concerns raised by staff regarding the alleged presence of a piece of asbestos on top of a control panel in air handling unit 1. Analysis of substance showed the material was white plaster containing synthetic mineral and cellulose fibres. There was no asbestos detected. The material posed no risk to health and safety as the fibres were contained within the plaster an as a result were not airborne.

Robson, 1 Sept 2003, Asbestos sample

Insulation material sampled from Air handling unit (AHU) 3 for asbestos content. Sample largely consists of Synthetic Mineral Fibre (SMF) with a small quantity of general dust. No asbestos detected.

Robson, 18 Nov 2003, Asbestos sample

Insulation material sampled from Air handling unit (AHU) 6 for asbestos content. Sample consists of Cellulose (plant material), Synthetic Mineral Fibre (SMF) and micaceous type material with a small quantity of general dust. No asbestos detected.

Robson, 15 May 2004, **Asbestos Inspection** and removal of asbestos rope lagging to hot and chilled water pipe penetrations by contractor. Monitoring of pump room adjacent boiler room and tunnel adjacent pump room was conducted. All airborne fibre monitoring results during asbestos removal were below the Minimum Practical Detection Limit of 0.01 Fibres per ml.

Robson, 18 May 2005, Asbestos sample

Ladies ground floor toilet exhaust dust analysed for asbestos due to concerns raised by staff – No asbestos found.

Robson, January 2007: Full asbestos audit and management plan completed

This is a very thorough and comprehensive document that provides a firm evidence base for the Gallery to plan and undertake asbestos-related control procedures.

Alan Pomeroy, Feb 1993, Air quality, including formaldehyde

Monitoring of formaldehyde was conducted in the following locations: Level 8 office areas, Conservation, Carpenters workshop, Restaurant, Art storage areas.

Results were interpreted against the Australian standard and were all found to be below the exposure limits.

Altree-Williams (ANUTECH), Feb 1995, (May report) Indoor air contaminants, including formaldehyde

Monitoring of formaldehyde levels in the following locations:
The roof of Gallery 1 (outdoor air), The combined return air / fresh air plenum in Air handling plant 2 (plant air), Nomura Court (indoor air).

Results were interpreted against the NHMRC indoor air quality guidelines for people. Measurable levels of formaldehyde were found in the outdoor air, but a detectable increase occurred within the NGA. This was expected to be associated with sources within the building. The formaldehyde and VOC levels were significantly below the guidelines and were considered unlikely to have any detrimental effect on the health of occupants or visitors to the Gallery.

MPL, Aug/Sept 1996 Indoor air

Air monitoring for formaldehyde was carried out in the kitchen, loading bay, plant room and workshop of the NGA to determine whether contaminants were present in the air and to what extent.

All results were well below the exposure standard of 1 ppm for formaldehyde (WorkSafe Australia). No contaminants were detected in concentrations that presented a hazard to health.

Robson, 23 Jan 2003, aldehyde levels

Monitoring of aldehyde levels in the Exhibition gallery following complaints of tiredness experienced by security guards in this area. Formaldehyde was the only aldehyde detected with an 8-hour TWA (Time Weighted Average) of 0.015 ppm, which is well below the WorkSafe Australia exposure standard of 1 ppm and approximately 5% of the ACGIH Ceiling limit of 0.3 ppm. However, this was above the level of 0.01 ppm where people sensitive to formaldehyde have reported irritant effects, such as eye irritation, nausea and headaches. It was recommended that formaldehyde levels be reduced by adequately sealing all compressed fibre board used in Gallery areas.

Comcare (Hogan, June 2003), MDF incident in Temporary Exhibition Gallery

The investigation concerned MDF dust from cutting MDF with a power saw in the temporary exhibition gallery over a two week period from 14th June 2003. The investigation was instigated following complaints from a staff member of dust not being contained in the structure erected by the contractors undertaking the work. The report found that NGA staff were exposed to dust which had escaped from the enclosure but at levels below the National Exposure Standard. Exposures were not considered to present an elevated health risk.

Robson, 2 Aug 2001, Airborne fibres

Airborne fibre monitoring was conducted to assess whether loose fibrous material located within AHU 1 zone ducting was being carried into Galleries 1 and 2. Monitoring results in Galleries 1 and 2 showed no airborne fibres were detected in the samples that were similar in appearance to the loose fibrous material present in the ducting.

Airborne fibres incident: Comcare- Trevanion report Jan 2004 for incident on 5th February 2003.

An incident occurred on 5th February 2003 involving the release of glass fibres into galleries serviced by Air Handling Unit 4. The fibre release was the result of tearing of the insulation lining (Comcare - Trevanion report). Fibres were noticed when they settled on floors and exhibits. A cleaner first noticed the fibres on 4th February 2003. Cleaning staff were advised (Risk Assessment by Robson Laboratories) to wear respirators while cleaning up the fibres on exhibits. However, some exposure may have occurred for several hours before the risk assessment carried out by Robson Laboratories. The air conditioning system was closed down during cleaning.

Static airborne fibre monitoring was conducted following the cleanup of Synthetic Mineral Fibre (SMF), which had become dislodged from the internal surfaces of air conditioning supply air ducts. The following locations were monitored:
Gallery 2, 7, 8, 8a, 9, 9a, 10a and 12, Cafeteria, Paper storage area, Visiting Scholars Room, Collection study, Study room.

Results showed that, although fibrous particulate matter was present on surfaces, no airborne fibres consistent with SMF were detected in the samples (Robson). Areas could be safely reoccupied. No asbestos was detected.

ACT Government Analytical Laboratories, 12 to 14 February 2003 - ACT Government Analytical Laboratories carried out analysis of surface fibre that had settled on exhibits. The identified yellow glass fibre in the samples. Robson laboratories had evidently not sampled surfaces for fibreglass.

ACT Government Analytical Laboratories, 17 February 2003 – monitoring of SMF in air by ACT Government Analytical Laboratories (see Trevanion report p16) results showed concentrations of 0.01 fibres/ml in Galleries 8 and 9 while < 0.01 fibres/ml was found in Gallery 9A and the Visiting Scholars Room. Air monitoring continued from 18th February until the end of March 2003. All samples showed concentrations were less than 0.01 fibres/ml.

ACT Government Analytical Laboratories, 12 March 2003, Airborne fibres

Sampling of airborne fibres was conducted at Galleries 2c (believed to be Gallery 2) and 9, Visiting scholars area and mount-cutting area of the Gallery. Levels of dust fibres monitored in all areas were significantly below the recommended NOHSC exposure standard (1003:1995).of 0.5 fibres / ml.

Robson, 6 Nov 2003, Airborne fibres

Static airborne fibre monitoring during removal of Synthetic Mineral Fibre (SMF) from internal surfaces of air conditioning ducts to Air handling unit (AHU) 3. Sample taken at level 8 administration area. The fibre count was typical of office type environments. The results showed that only one fibre was detected in the entire sample, which gave a concentration below the Minimum Practical Detection Limit of 0.01 Fibres per ml.

Robson, 7/8 Nov 2003, Airborne fibres

Static airborne fibre monitoring following spillage of Synthetic Mineral Fibre (SMF) from internal surfaces of air conditioning ducting at the Gallery's off-site storage premises premises. Sampling done prior to, during and after SMF clean up. The areas monitored were the Sculpture store adjacent the paint store, Sculpture store, Adjacent to register HB 080901, H55 3A1 opposite stillages, H55 683 opposite stillages and the paint store adjacent to the door to textiles.

No estimation of workers exposure could be given due to the fact that samples were required as background samples. Only 0 – 1.5 fibres were observed on the filters (well below the Minimum Practical Detection Limit of 0.01 Fibres per ml) and it was deduced that the level of airborne SMF was not significant and the premises could be safely occupied.

Robson, 12 Nov 2003, Airborne fibres

Static airborne fibre (SMF) monitoring during vacuum cleaning of library books and shelves on the first floor Library areas. The cleaning was carried out to remove general accumulated dust and any fibre glass released to the internal insulation of the air conditioning ducting. No estimation of workers exposure could be given due to the fact that samples were required to be taken as background samples. Only 0 - 1 fibres were observed on the filters and it was deduced that the level of airborne SMF was not significant and the premises could be safely occupied.

15-19 Nov 2003, Respirable dust

Respirable airborne particulate monitoring done at Gallery 6 adjacent to air conditioning duct cleaning works being performed in Gallery 5 to remove dust and debris and any loose fibre glass insulation. The 8-hour Time Weighted Average (TWA) was well within 'normal' background levels for occupied buildings (< 5 $\mu g/m^3$). Dust levels generated by the works were less than levels typically recorded in general office buildings located in Canberra (5 – 20 $\mu g/m^3$).

Robson, 18 Nov 2003, Airborne fibres

Static airborne fibre (synthetic mineral fibres SMF) monitoring during cleaning of air conditioning ducts supplying Gallery 5. The cleaning was carried out to remove general accumulated dust and any fibre glass released to the internal insulation of the air conditioning ducting. Samples taken at Gallery 4, 5 and 6. No estimation of workers exposure could be given due to the fact that samples were required to be taken as background samples. Only 0 – 6.5 fibres were observed on the filters and it was deduced that the level of airborne SMF was not significant and the premises could be safely occupied.

Robson, 3 Dec 2003, Airborne fibres

Static airborne fibre monitoring following concerns raised by staff that maintenance works associated with AHU 4 had dislodged internal fibre glass insulation and distributed airborne fibres into occupied spaces. Sampling done in Registration Curator's Row area lower ground floor. No estimation of workers exposure could be given due to the fact that samples were required as background samples associated with maintenance works. Only 0 – 1.5 fibres were observed on the filters and it was deduced that the level of airborne SMF was not significant and the premises could be safely occupied.

Robson, 5 Feb 2004, Airborne fibres

Static airborne fibre (synthetic mineral fibres SMF) monitoring during cleaning of air conditioning ducts supplying Gallery 9. The cleaning was carried out to remove general accumulated dust and any fibreglass released from the internal insulation to the air conditioning ducting. No estimation of workers exposure can be given due to the fact that samples were required as background samples. Zero (0) fibres were observed on the filters and it was deduced that the level of airborne SMF was not significant and the premises could be safely occupied.

Cellulose identified in workshop air conditioning ducts: Comcare – Hogan, 21 Nov 2003, Airborne fibres incident (Hogan report Feb 2005)

Concerns were raised on 21 Nov 2003 about an incident where an unidentified substance was being expelled from the air conditioning ductwork in the NGA's workshop. There had

been several incidents of a similar substance being expelled to the workshop air conditioning ductwork over the previous three years.

Analysis of a sample of the insulation material from the air conditioning ductwork taken on 24 Nov 2003 showed the material was cellulose. No asbestos was found in the sample. Some unidentified fibres were found in the sample, which were matched to a database of hazardous substances by both description and picture. The approach used is that if no match is found, the substance remains unidentified but is classified as non-hazardous.

Dust samples taken from surfaces at five locations in the workshop on 24 Nov 2003 again showed cellulose fibres and no presence of asbestos. Some of the cellulose fibres appeared to be coming from wood particles.

Monitoring of airborne fibres was done on 21 and 26 Nov 2003 in the carpentry and metal workshop area. All results were below the Minimum practical detection limit for airborne fibres of 0.01 fibres / ml.

Monitoring of airborne fibres was done on 24 Nov 2003 in five locations of the workshop. Results showed < 0.01 to 0.01 fibres / ml. The report states that '*cellulose has no specific TWA (Time Weighted Average) set for it, so a TWA of 10 mg/m^3 is used*'. This is consistent with the NOHSC's guidance note on the interpretation of exposure standards for atmospheric contaminants in the occupational environment[12]. This states that '*where no specific exposure standard has been assigned and the substance is both of inherently low toxicity and free from toxic impurities, the recommended exposure for dust in general should be 10 mg/m^3*'. The measured fibre count was at least 1000 times smaller than the TWA.

Visual inspection of the condition of the ductwork insulation in the air handling system serving the workshop showed there was no evidence of any damage or exposed edges to the internal insulation of the air handling system or loose pieces of fibreglass insulation. There was dirt and lint build up on the internal services of the plenum and ductwork. It was suggested to install a metal filter frame to prevent any bypass. A removable, cleanable metal frame filter was installed in the workshop air conditioning ductwork in January 2005. Additional inspection plates were also installed in the ducts. Cleaning of the workshop air conditioning ductwork was undertaken on 9 Dec 2003 and regular inspection and cleaning was to be included in the future maintenance schedules.

Alan Pomeroy, Survey Feb 1993, Air quality

Monitoring of carbon dioxide, formaldehyde, dust and ozone. Sampling locations were:
Level 8 office areas, Conservation, Photocopy area in the registry
Information desk, Carpenters workshop, Restaurant, Art storage areas
Results were interpreted against the Australian standard and were all found to be below the exposure limits.

Various Consultants, 1990 – 1997, Cooling tower water analysis

Regular analysis of cooling tower water for Legionella. The majority of results showed no Legionella detected by the method. Some results however showed unacceptable levels of Legionella bacteria detected in samples. Action was always taken after elevated levels such as switching off air conditioning, cleaning the towers and sterilising the water (super chlorination). Re-testing was done to verify that Legionella was not present.

MPL, Aug/Sept 1996, Indoor air

Air monitoring was carried out in the kitchen, loading bay, plant room and workshop of the NGA to determine whether contaminants were present in the air and to what extent.
The following contaminants were monitored:
Oil mist (Standard 5 mg/m^3)
Inspirable and respirable dust (Standard 10 and 5 mg/m^3 respectively)
Volatile Organic Compounds (VOCs; Standard 1640 mg/m^3)
Formaldehyde (Standard 1 ppm)
Oxides of Nitrogen (Standard 3 ppm)
Hydrogen sulphide (Standard 14 mg/m^3)
All results were well below the relevant exposure standards (NOHSC). No contaminants were detected in concentrations that presented a hazard to health.

Graham Moon Incident Report, 27 September 1995. Coil and Filter cleaner AK30

Incident (25 Aug 1995) report of staff member complaining of loss of voice and respiratory problems, possibly cause by the use of AK30 coil and filter cleaner. Fumes were apparently circulating through the gallery and this staff member and some security staff were affected in some way. AK30 is a perfumed heavy duty alkaline cleaning agent, diluted with water at ratio 10:1 (water:agent) for use. Corrosive, but not carcinogenic according to the MSDS. The exposure level experienced by staff was by highly diluted perfume as the air re-circulated over the cleansed coils. No previous complaints have been made about this product and it was thought that symptoms might have been an allergic reaction to the perfume base. There is insufficient data to confirm or deny that

the product, or its fragrance, particularly in the highly diluted state in which it was circulating was the cause of the symptoms.

ANU Altree Williams, Feb 1995 survey, May 1995 report, Indoor air contaminants

Monitoring of carbon dioxide, formaldehyde, particulates and Volatile Organic Compounds (VOCs). Sampling locations were:
The roof of Gallery 1 (outdoor air)
The combined return air / fresh air plenum in Air handling plant 2 (plant air)
Nomura Court (indoor air)
Results were interpreted against the NHMRC indoor air quality guidelines. The levels of all indoor air contaminants investigated were significantly below these guidelines and are unlikely to have any detrimental effect on the health of occupants or visitors the Gallery. On the basis of the contaminants investigated the National Gallery of Australia was found to have a high standard of indoor air quality in regards to human health.

Robson, 24 Dec 1999, Cooling water and scale samples

Samples of cooling water and scale to Air Handling Unit 7 were analysed to determine the presence of any substances within the water, which may compromise the occupational health and safety of staff and maintenance personnel. Results showed that the level of bacteria in the cooling tower water was significantly lower than often occurs in environmental water. The concentration of metals in the water samples meet the health guideline values for drinking water as referenced from the NHMRC 'Australian drinking water guidelines', 1996. Therefore the present concentrations of metals in cooling water do not pose a significant health risk.

The alkalinity of the water may be high and pH levels > 8.5 can cause scale build up. Also, at pH > 8 the efficiency of chlorination progressively decreases. It was recommended to assess the pH over weekly period to determine time history of the alkalinity of the cooling water to determine efficiency of chemicals added in controlling scale, corrosion and microbial growth. The dosing rate of biocides and chemicals should similarly be assessed. Regular checks are required to be undertaken to ascertain and to ensure concentrations of Legionella bacteria are kept low in cooling tower water. To reduce risk of exposure to airborne contaminants of any personnel entering the air handling unit areas, PPE was recommended to be worn if there was a risk of exposure to spray mists, droplets or water treatment chemicals.

Robson, 13-20 Jan 1999, Airborne dust

Monitoring of airborne dust was carried out in the level 3 reading room and mezzanine office area to assess the internal air quality. Dust samples were collected for analyses to determine their composition. The dust samples were found to contain cellulose fibres, which are typical of paper fibres found in stored books and library areas. The samples were taken from locations, which had not been cleaned for some time. Dust monitoring results showed that during normal occupation of the building airborne dust levels are well below the NHMRC (National Health and Medical research Council) recommended maximum level of 90 $\mu g/m^3$ (measured as an annual geometric mean). According to current knowledge exposure to airborne particles at the recorded levels should not cause adverse health effects or undue discomfort to nearly all people. It was recommended to undertake a major clean of all exposed dust collecting surfaces on a regular basis to help reduce the amount of dust available to become airborne if disturbed.

Comcare-Maguire, 24 Feb 2000, Air conditioning incident (Report No. 1913 April 2000)

Concerns were raised on 24 Feb 2000 that the air conditioning system at the NGA was causing ill health in employees and other persons visiting NGA. It was further alleged that the ill health was caused by failing to maintain the building air conditioning system at Parkes Place.

An investigation was conducted that reviewed a range of maintenance procedures, testing of water and air quality, review of illnesses reported by NGA staff. Mr Broadbent provided expert opinion for the investigation.

Results have concluded that the system of maintenance and cleaning the humidifier system and water are appropriate. However, the build up of deposits indicates that the interval between cleaning cycles may require review.

Testing of air quality and water between May 1999 and January 2000 showed that both met the recognised standards, including the NHMRC drinking water guidelines 1996. Results were consistent with the humidifier water being supplied from the Canberra Mains water supply.

There was no evidence that contaminants have entered the air conditioning system indicating that, in all probability, maintenance and cleaning has been conducted regularly and in accordance with established regimes. Mites in the system were identified in tests conducted by the CSIRO. They were, in all probability, introduced by insects, including mosquitoes, which may be attracted to the moist atmosphere within the air conditioning

system. If maintenance is conducted according to established regimes, the air conditioning plant does not represent a risk to health and safety.

During this investigation it could not be established that any illnesses were directly attributable to the NGA building. The report (Broadbent) concluded that "it was difficult to imagine that these plants could result in adverse occupational health effects since the elimination of isothiazolone mixture in 1991". Isothiazolone compounds were used for cleaning the air-conditioning system prior to 1991. This issue is discussed in Section 7.3 of this report.

Robson, 15-19 Nov 2003, Respirable dust

Respirable airborne particulate monitoring done at Gallery 6 adjacent to air conditioning duct cleaning works being performed in Gallery 5 to remove dust and debris and any loose fibre glass insulation. The 8-hour Time Weighted Average (TWA) was well within 'normal' background levels for occupied buildings (< 5 $\mu g/m^3$). Dust levels generated by the works were less than levels typically recorded in general office buildings located in Canberra (5 – 20 $\mu g/m^3$).

Robson, 17 June 2004, Particulate sample

Analysis of dark coloured particulate sample collected from the Gallery storeroom.
Particles consisted of:
Organic matter, Rust or Iron oxide, Glass fibre, Particles with high concentration of tin and / or copper, Zinc oxide
No asbestos or substances considered to be hazardous to human health were detected in the sample. Materials were typical of particulates found in air-conditioning systems and plant room areas.

Robson, 30 April 2004,Particulate sample

Analysis of white powder found on Gallery floor. Powder is mineral and chemically inert. Strong indication that powder is Plaster of Paris due to low water content.

Robson, July 2005, Air Quality and H&S issues including EMF

Concerns were raised by security staff regarding potential exposure to harmful or toxic substances or environments in the Gallery. They are required to work in all areas of the NGA, exposing them to a wide range of indoor environments. The concern is that over a number of years exposure to even moderate concentrations of substances in the workplace might result in adverse health effects. Monitoring was done of the following:

Sample and identification of airborne mould on ramp between Gallery 8 and 9, guard's tea room and security room

Analysis of surface dust for mould on ramp between Gallery 8 and 9, parcel collection and staff entrance
Personal sampling of inspirable particles
Sample carpark dust for lime sampling in underground public carpark
Sample and analysis of drinking fountain water in security tea room
Microwave oven in security tea room
Magnetic field testing in security control room (fire safety cabinet)
Thermal comfort and ventilation test in Security control room

All parameters were assessed against relevant Australian and US standards or guidelines. Measurement of each of the parameters according to established methods, could find no indication of occupational hazards. That is, analysis of substances security staff inhale or ingest indicates they are non-toxic, and there was no evidence of above-average electromagnetic field exposure. In terms of the parameters measured, the Gallery is probably comparable to other public buildings of its size and capacity.

Black Dust in air conditioning system

Black dust in the AC ducts and plinths (Gallery 9 & 10) has been observed over several years since the early 90's. There was concern that the dust could be carcinogenic and a hazard to health.

The chronology of testing and advice is as follows:

Alan Pomeroy & Associates, Feb 1993

Dust analysis found that contaminants were "well below the exposure limit specified in the Australian Standard".

Anutech Pty Ltd May 1995

evaluated indoor air contaminants and found that "Airborne particulates were composed predominantly of organic and rock materials. There was no significant level of cement dust found. The majority of non-natural particulates identified were composed of iron. On the basis of the contaminants investigated the National Gallery of Australia was found to have a high standard of indoor air quality in regards to human health"

Robson, Jan 1999, airborne dust

Monitored airborne dust and found "during normal occupation of the building airborne particulate levels are well below the NH&MRC goals for permissible concentrations in indoor air".

Robson, Dec 1999: Analysis of air-handling plant cooling water and scale samples.

"The concentration of metals in the water samples meet the health guideline values for drinking water as referenced from the National Health and Medical Research Council's 'Australian Drinking Water Guidelines', the major components of the scale are copper and iron salts."

Robson, 9 Aug 2001. Black Particulates associated with AC system

Robson Laboratories investigated the black dust and found that it consisted of inorganic dust particles (minute disintegrated rock particles) with a covering of fatty acids. The fatty acids were believed to have arisen from body odour organics released from human skin. It was also believed that some carbon from vehicle exhaust was also adsorbed onto the dust. The black particulates were not considered to be a health hazard.

Robson, 7-14 Oct 2002, Particulates

Monitoring of airborne particulates at the Level 3 Library Mezzanine and Education office area to determine whether air passing through the air conditioning system was adequately filtered and to assess airborne particulate concentration levels. Staff members were concerned about the dust accumulation on equipment from overhead registers in the Library Mezzanine area. Total suspended particulates (TSP) / Respirable suspended particulates (RSP) were measured. The average airborne particulate concentrations of approximately 23 $\mu g/m^3$ within the two areas were well below the NHMRC (National Health and Medical research Council) recommended maximum level of 90 $\mu g/m^3$ for tsp in air (measured as an annual geometric mean). According to current knowledge carbon dioxide and carbon monoxide exposure at the recorded levels should not cause adverse health effects or undue discomfort to nearly all people. The planned upgrade of the air conditioning ducting system and consecutive cleaning of the Library registers should have resolves the issue of dust accumulation.

Murdoch University, (See also Mould Section below). Dingle & Cheong, 9 Sept 2002, Indoor environmental investigation

The focus of this investigation was the following:

- To determine airborne viable fungi, surface concentration and fungi in carpet dust following recent upgrades of the HVAC system.
- To establish general symptomatology of the building's occupants by undertaking an occupant questionnaire.
- To establish baseline conditions in the building by monitoring indoor air quality and environmental comfort parameters, i.e. suspended particulates, air temperature, relative humidity, carbon dioxide, airborne and surface fungal contaminants
- To identify building related problems that may be impacting on the health, comfort, productivity or absenteeism of the building occupants.

The following areas were monitored for indoor air quality:
Administrative offices, Conservation Department, Photography, Library, Art storage, Main bookstore, Air handling unit (AHU) 2

Results suggested that the air quality and airborne viable fungi within the building were within acceptable ranges and posed no immediate risk to employees in the occupied areas that were investigated. The building occupant survey showed that there was no particular environmental condition or health symptom that warranted immediate action and that the modification and upgrade of the HVAC system appears to have remedied previous instances of mould growth and problems.

Regular air quality monitoring and a mycological investigation were recommended. Direct two-way feedback and communication between employees and maintenance staff could facilitate better management of the balance between comfort of employees and the preservation of art work and artefacts.

Robson, 28 July 2002, Particulates
Risk assessment of exposure to airborne particulates / odours during ramp replacement works. Work done after hours. Air conditioning system expected to continually dilute concentration. Exposure expected to be very low and well below current exposure standards for toluene. Health effects from toluene exposure not significant for building occupants.

Robson, 16 June 2002, Toluene
Risk assessment of exposure to toluene during ramp floor tiling works. Work done after hours. Air conditioning system expected to continually dilute concentration. Exposure expected to be very low and below current exposure standards for toluene. Health effects from toluene exposure not significant for building occupants.

Robson, April/May 2002, Indoor air quality
Monitoring of carbon dioxide, temperature and relative humidity in the Security office to assess the internal air quality.
Carbon dioxide levels detected during sampling ranged from 400 to 750 ppm. During normal occupation of the building carbon dioxide levels within the Security Office were below the TWA (Time Weighted Average) exposure standard of 5,000 ppm and less than the recommended acceptable indoor air level of 800 ppm. According to current knowledge carbon dioxide exposure at the recorded levels should not cause adverse health effects or undue discomfort to nearly all people.

Temperature & Relative humidity levels in the Security control room areas were within their respective comfort ranges of acceptability during normal office hours during the monitoring period.

Robson November 2002: conducted an indoor air quality survey and found that - "Air sampling undertaken in November 2002 resulted in particulate concentrations below 20 $\mu g/m^3$."

ACT Government Analytical Laboratory, February 2003
analysed particulate matter from library air conditioning for COMCARE and found that – "this material should present a minimal health risk."

Robson, 13 Aug 2003, Black Particulate sample
Analysis of black dust like particles found on work surfaces and on / adjacent air conditioning registers in Level 8 Public Affairs Office and Marketing Managers Office. Workers complained of itching, sneezing and minor eye irritations. Workers were relocated temporarily until test results were known. Results showed that the main source of fibres was likely to be from staff clothing and office carpet. No glass fibres were detected in the samples. The presence of black particulates is a relatively typical occurrence in air conditioned buildings and is not considered to be a health hazard. The same would apply to the build-up of dust and fibrous particulates on workstation surfaces.

ACT Government Analytical Laboratories, 27 March 2003, Particulates
Sampling of airborne particulates (Total suspended particles (tsp) and respirable fraction) was conducted at Human resources, the Research Library and the Education area (control) due to dust coming from the Library air conditioning. Analysis of this surface dust on 7 March 2003 showed presence of copper(II)carbonate, iron(III)oxide (rust), quartz and mica. All 8-hour TWA (Time Weighted Average) exposure levels were well below the NOHSC (National Occupational Health and Safety Commission) exposure standards for copper, iron, quartz and mica, i.e. 1 mg/m^3, 5 mg/m^3, 0.2 mg/m^3 (now 0.1mg/m^3) and 2.5 mg/m^3 respectively. Levels of dust monitored in all, areas were also below the NOHSC exposure standard of 10 mg/m^3. The dust levels in Human resources and the research library were below that of the education area, which was the control and not exposed to the same dust from the air conditioning system. This might have been due to the new filtering system or the large size of dust particles leading to quick deposition. It is unlikely that suspended material at the concentrations in which they are found in the air will appreciably contaminate any foodstuffs. The risk of contamination of food or drink placed directly under the air conditioning vents due to deposition of heavier particles is uncertain. It should be noted that static samples were taken and any levels

measured are approximations due to the fact that NOHSC guidelines are based on personal sampling results.

ACT Government Analytical Laboratories 7 March 2003, Particulate sample
Analysis of particulate matter from the Library air conditioning duct, which showed presence of copper(II)carbonate, iron(III)oxide (rust), quartz and mica. This material should present a minimal health risk.

Robson, 7-9 Feb 2003, Particulates: Monitoring of airborne particulates in the Visiting scholars area, Gallery 9 and Collection study to assess whether airborne particulate levels were elevated in these areas. Total suspended particulates (TSP) / Respirable suspended particulates (RSP) were measured. The average airborne particulate concentrations of approximately 15 $\mu g/m^3$ within the three areas were well below the NHMRC (National Health and Medical research Council) recommended maximum level of 90 $\mu g/m^3$ for TSP in air (measured as an annual geometric mean). According to current knowledge carbon dioxide and carbon monoxide exposure at the recorded levels should not cause adverse health effects or undue discomfort.

Robson, 23 Jan 2003, Indoor air quality: Monitoring of carbon dioxide and carbon monoxide levels in the Exhibition gallery following complaints of tiredness experienced by security guards in this area.
Carbon dioxide levels detected during sampling ranged from 350 to 600 ppm. During normal occupation of the building carbon dioxide levels within the Security Office were below the TWA (Time Weighted Average) exposure standard of 5,000 ppm and less than the recommended acceptable indoor air level of 800 ppm.
Carbon monoxide levels during normal occupation of the building were well below the TWA exposure standard.
According to current knowledge carbon dioxide and carbon monoxide exposure at the recorded levels should not cause adverse health effects or undue discomfort to nearly all people.

Regular dates **Water samples AHU's**: Water samples taken from AHU's sometimes indicate high bacterial levels (standard plate counts). Generally levels below 1,000,000 are of no great concern. If levels are high AHU's are cleaned.

Murdoch University, Dingle & Cheong, 9 Sept 2002, Fungal investigation

Airborne viable fungi, surface concentration and fungi in carpet dust were monitored following recent upgrades of the HVAC system. The following areas were monitored: Administrative offices, Conservation Department, Photography, Library, Art storage, Main bookstore, Air handling unit (AHU) 2,

Results showed levels within acceptable ranges and posed no immediate risk to employees in the occupied areas investigated.

Robson, Survey 19 Jan 2004, Mould / Bacteria

Sample of fibre glass duct insulation and dust / rust sample from rusted fly wire taken from air conditioning duct AHU 2 – Duct 2. Analysis for microbial contamination to determine presence of fungal spores / growth and bacteria. Some bacterial and fungal growth detected, but the level of concentration of general environmental bacteria and fungi is low. It is not unexpected to find low levels of bacteria and fungi in building air conditioning ducting environments.

Robson, Survey 24 Aug 2004, Mould

Mould swabs (3) taken from walls in Gallery storage areas, i.e. Paper storage section and Art storage office. Mould / fungal growth on walls due to moisture build-up was extensive and probably occurred over several months. No strong odours reported. Aspergillus Versicolor and Cladosporium species found in paper storage section. Aspergillus species can produce mycotoxins and cause opportunistic infections, but there is no evidence that this growth has contributed to health effects at the national Gallery of Australia.

Robson, Survey 21 Feb 2005, Report 24 March 2005, Bioaerosols

Assessment of aerobiology concentration in Gallery for use as a 'benchmark' standard for the building. This test was to be part of quarterly testing program. Samples for mould bioaerosols were taken in the following areas:

Registration corridor, Val's office, Collection study room, Gallery 8A landing

Ramp between Galleries 8 and 9, Photography negative storage, Gallery 6

Library, Outside director's office.

Interpretation is based on comparison between indoor and outdoor concentrations, as well as identification of 'indicator' species. The measured concentrations indicate mould levels are typical for indoor areas. There is no evidence of mould amplification.

Robson, May 2002, Magnetic fields

Magnetic fields were measured around the security control room in May 2002. The report concluded "The value of the magnetic field strength measured at various work locations within the security Control Room ranged from 0.03 – 0.74 A/m (0.04 – 0.9μT). These values are significantly below the *National Interim Exposure Guidelines*. The Guidelines for the general public for continuous exposure to 50Hz magnetic fields is 80 A/m.…The magnetic field strengths are similar to typical exposure values experienced in the average US home and office areas adjacent the areas of concern….Based on these two findings which were reported within the last twelve months the likelihood of there being any long term health effects of persons occupying workplaces where levels at or below 0.8 A/m are considered to be extremely low or negligible.".

Robson, January 2003, Measurement of Magnetic Field Strength

Magnetic field strength was made on 23 January 2003 in the Exhibition Gallery in the area of Blue Poles. The measured levels (0.025 to 0.20 μT) were significantly below the continuous exposure limit. The report includes a discussion of research into the health effects of magnetic fields and concludes that "the likelihood of any long term health effects of persons occupying workplaces where levels are at or below 1.0 μT are considered to be extremely low or negligible".

Robson, July 2005, Magnetic fields

Magnetic fields were measured in the Security Room around the fire safety cabinet which was considered as a main source of electromagnetic radiation in the area. Results showed that magnetic fields were well within the NHMRC interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields. These limits represent levels below which predicted and established immediate health effects are unlikely. **Microwave radiation** was also measured at the Guard's Tearoom microwave oven. No leakage was found.

APPENDIX 5: RESPONSE TO STAFF QUESTIONS ON VARIOUS ASPECTS OF OCCUPATIONAL HEALTH AND SAFETY

INTRODUCTION

In 2005, Gallery staff members prepared a list of occupational health and safety issues about which they requested information ("*Security Section Questions: Updated Schedule as at 22 September 2005*"). The Gallery management undertook to provide answers to these questions and have collected relevant information to allow this to be done. Most of these questions were already answered prior to this study beginning and others have been answered since or have been answered by the findings of this study. Responses to these questions are provided here, with an indication as to whether the answer was prepared by Gallery management (the text is put in quotation marks and italics, and "Gallery" is recorded as the source) or by the report's authors ("Authors" is recorded as the source). Some questions are not answered, or not answered completely, because the necessary information is not available and/or the question is beyond the scope of the current project.

No	Question	Response	Source of response
1	What types of chemicals have been used by the Gallery over the last 20 years?	*"Have reviewed register of purchase orders through stores for the period and identified chemicals from Purchase Orders and Chemical Register – none of these chemicals are on the NOHSC list of known carcinogens. Have been unable to obtain records from DAS, who were responsible for maintenance of the A/C system for a number of years – still trying to source documents"*	Gallery
2	Are any of these chemicals dangerous to the immediate & long term health of employees working in the Gallery at the time of their use?		
3	In what way are these chemicals dangerous?	This report addresses carcinogenic hazardous exposures. The specific questions should now be answerable through the use of the Gallery's Risk Register and the information provided in MSDSs for the hazardous substances.	Authors
4	What sickness could result from exposure to these chemicals? Immediate & in the long term?		

No	Question	Response	Source of response
5	Being exposed to wet, damp and mould on internal walls during winter. The effect that could have on our respiratory system?	*"Refer results in Robson Laboratories report – no organisms were detected. Additional information has been provided to educate staff on the elements necessary for mould in an indoor environment to constitute a health risk."*	Gallery
6	Assistant Managers & Senior Officers and acting Senior Officers working in the office downstairs where there is radiation emitting equipment and no ventilation. What are the effects on our health in regards to this exposure?	*"Magnetic fields were measured in the Security Room around the fire safety cabinet, which was the main source of electromagnetic radiation in the area. Results of testing found the H-fields were well within the NHMRC Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields."*	Gallery
7	Can the dust, fluff & dirt etc that has accumulated on the roof of the parcel in/out desk opposite the Control Room be tested for? It has been there for years and would be a good indication of what is in the air.	*"Refer results in Robson Laboratories report – no mould organisms were detected. Additional information has been provided to educate staff on the elements necessary for mould in an indoor environment to constitute a health risk."*	Gallery
8	Is the build up of lime deposits in the underground car park of consideration? Is it all through the concrete in the building? What effect does lime have on people? .	*"Concrete dust in the public underground car park (measured over a 6 hour period) was below detection limit. Although sampling found particulates, analysis of the particulates did not detect calcium or silicon (constituents of cement). Additional information provided on exposure to concrete dust."*	Gallery
9	If we went to our respective GP's, what are we asking them to check for and what do we say to them?	There is no reason to think it would be helpful to have a medical review when there are no specific symptoms. Therefore, it is not recommended that staff members visit their GP to be reviewed "just in case". If the GP is concerned, he/she can contact the Gallery OHS officer to discuss the specific issues.	Authors.

No	Question	Response	Source of response
10	At the lower tea room we have microwave and drinking fountain; would these two be linked to security officer's illnesses.	*"No leakage was detected through testing of the microwave oven in the security tearoom."*	Gallery
11	Is it safe to have a restaurant (Sculpture Garden) next to an air conditioning cooling tower?	*"Advice has been provided by Steenson Varming on the Statutory requirements for siting of cooling tower discharges."*	Gallery
12	Like to know what were the effects of the smell coming from……the air conditioning system. How would the chemicals effect my health and my co – workers. .	*"The construction and operation of spray humidification systems made them susceptible to occasional growths of algae (in the form of green slime). While the algae remained fully wet (as it did during normal operation) it gave no odour. However, at times when there were failures in a component of the spray humidification system (e.g. a failure in the spray pump) which led to a drying out of the algae this is when the odour arose."*	Gallery
13	Where did the log book containing all the relevant information about security conditions & sick leave go?	This log book was found very late in the investigation and a copy was inspected by the authors. The contents and the incidents/illnesses described were very similar to those already seen in various documents provided earlier in the investigation. The incidents/illnesses were non-specific and certainly not suggestive of the presence of carcinogenic exposures. Most incidents/illnesses appeared to be related to bad odours and their effects and so were most likely related to the old air-conditioning system before it was replaced.	Authors
14	Current lighting is affecting our sight. Five years ago you could look towards the ceiling and not have a light shine in your eyes. Currently this is not the case – (yearly eye sight tests required). .	*"Lighting levels still to be measured, so that we have a base to compare against the different requirements for different environments."* The adequacy of the lighting is easily established through appropriate testing and, if this assessment has not already been completed, the Gallery OHS officer can arrange for this to be undertaken.	Gallery Authors

No	Question	Response	Source of response
15	Security personnel should have a complete MRI body scan to see if there are any problems associated with exposure to "unknown chemicals".	There is no evidence to suggest such screening Magnetic Resonance Imaging would be helpful from a medical point of view for members of the general public, and such screening investigations are certainly not recommended for Gallery staff members.	Authors
16	Security officers are often subject to work in extremely low lighting conditions. This must have physical/psychological effect on our bodies i.e. work performance, sleep pattern etc.	See the answer to question 14. No more information available at the moment.	Authors
17	The exhibition wing smells whenever it rains. We are told this is the de-humidifying process. But why does it smell?	*"This occasionally occurs whenever the dehumidifiers are brought back on line after a prolonged shutdown. The dehumidifiers are used to extract excess moisture out of the circulated air in the Gallery spaces during periods of high ambient relative humidity. During the off-season some dust may accumulate on the heat/moisture out of circulated air in the Gallery spaces during periods of high ambient relative humidity. This is part of the normal operations of the HVAC system. As the dehumidifiers are brought back on line it is this dust that causes the odour. Typically the smell only lasts for a short period of time.* *The service providers have been asked to provide a methodology with regard to how this situation can be avoided. Typically it may occur during the seasons of high relative humidity such as late winter and spring, and again in late summer and autumn. Building Services are also reviewing the maintenance management for these items of plant."*	Gallery
18	Fiberglass! The stuff we breathed in that day. When was it installed? Biodegradable Fiberglass wasn't compulsorily manufactured until 2000 – 2001 in Australia.	*"The fiberglass was installed in April/May 2002. It is type FBS-1 glass wool insulation which is bio-soluble."*	Gallery

No	Question	Response	Source of response
19	Affects of 20 years of concrete dust???	*"Refer question 8 – Particulate monitoring was undertaken by Robson Laboratories – personal sampling of 2 security officers during typical one-day shifts. Analysis found inspirable dust concentrations to be well below the recommended exposure standard for dusts. There is at present no evidence that the particulates security staff are exposed to during typical working shifts at the NGA are of a toxic or carcinogenic nature."*	Gallery
20	Should the Gallery be found liable in any way either large or small, just what are they prepared to do? What sort of compensation is offered once the damage is done?	Not a health question.	Authors
21	History of cleaning schedule?	*"From 1982 to approximately 1995 occasional cleaning of the cooling coils in AHU's 1,2,4&7 was carried out to reduce the accumulation of calcium scale build up. This scale build up is a natural result of using water spray-type humidification. In about 1995 this regime was intensified as the scale build up started to affect the performance of the cooling coils. Eventually the coils became unserviceable and were replaced in 2001-02. With the replacement cooling coils and with the replacement of the water spray humidification with ultrasonic humidification the cause of the scale build up has been removed. Since the cause has been removed the coils will not require cleaning in the future."*	Gallery
22	What was used to clean filters ducts etc?	*"The air filters have always been of the disposable type. This means that they are replaced not cleaned. The air conditioning duct system was first cleaned as part of the current Gallery Enhancement Projects Phase 2 works. This was done by vacuuming with high efficiency industrial vacuum cleaners."*	Gallery
23	The type of bacteria being treated with the system?	*"In the old system there was no testing for bacteria. There was a periodic dosing regime of the spray humidifier water tank and spray distribution system with chlorine-based biocide. The current service regime in the air handling system only requires that the ultra sonic humidifiers have a proactive clean once each month. This is done to diminish the potential for the occurrence of Legionella bacteria."*	Gallery

No	Question	Response	Source of response
24	The levels of bacteria present?	*"Prior to the replacement of the cooling coils and the installation of the ultrasonic humidification system there was no testing for bacteria. The system is now tested once a month to detect levels of Legionella in accordance with AS3666 and the ACT Code of Practice for Cooling Towers and Warm Water Systems. Each month it is reported that bacteria count detected is below reportable levels."*	Gallery
25	To be provided with information on the present and future cleaning programs.	*"The systems are cleaned once a month. Each clean is preceded by a Gallery wide email notification.* *Further tours to be arranged for staff (including Security staff) if required."*	Gallery
26	To be provided with a report each time bacteria testing is carried out.	*"Building Services will forward a copy of each report to the OH&S Officer. OH&S Officer to report on at Committee meetings which are minuted."*	Gallery
27	What chemicals currently are being used in the cleaning program? Refer question 25	*"Either Regent disinfectant or Glitz Pine disinfectant. Material Safety Data Sheet (MSDS) for both products is available at the Control Room and in Building Services."*	Gallery
28	What will be the procedure put in place if any of the current or previous staff are diagnosed with cancer, legionaries or Salmonella poisoning?	Each case should be examined on its merits, with appropriate medical investigation and treatment, and workers' compensation procedures followed as with any potentially work-related condition. In addition, implications for other staff would need to be considered.	Authors
29	What are the potential short and long term effects to health due to exposure to fumes/vapours whilst the Islands Exhibition was on?	See Section 7.11. The available information suggests exposure would not have resulted in short-term or long-term adverse health effects. The oil contained very small amounts of benzene and polyaromatic hydrocarbons (based on the information provided in the Tri State Oil Pty Ltd MSDS). Some volatile components of the oil would have been present in the room but at a very low level. Motor oil has a low volatility and only becomes a respiratory hazard when in the form of a mist or if heated to generate vapour.	Authors
30	Is there a likelihood that exposure could lead to the risk of cancer, leukemia or peripheral nerve damage in the future due to working in close proximity to this exhibition?	See the response to question 29.	Authors
31	Could the report by Comcare OHS Officer, Peter Maguire, in relation to the possible effects to staff and public be made available?	Not a health question.	Authors

No	Question	Response	Source of response
32	Could the effect of any chemicals used in the Gallery be examined and the long term effects of officers who have been exposed to them – Assault (Alkaline Stripper) used in the galleries to strip the floors. Refer question 1-4 – to be addressed here.	See the responses to questions 1 to 4.	Authors
33	Examine changes to MSDS details for chemicals used – were they more dangerous previous to current forms? Refer question 1-4 – to be addressed here.	See the responses to questions 1 to 4. It is difficult to be certain which chemicals were used in the past. It is likely that substances used in past years were more hazardous than substances used more recently. The available information does not suggest these would have been a major problem but the information is incomplete. The length and intensities of exposure of security guards are unlikely to have been high enough to result in significant adverse health effects.	Authors