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WorkSafe Western Australia

SAFE WORK MONTH 2023

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occupational health and hygiene forum

Tuesday, 3 October 2023

#safeworkmonth

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SAFE WORK MONTH 2023

Master of Ceremonies
Geoff Hutchinson

Housekeeping

Please put your mobile phone on silent

Location of toilets

No smoking on premises

Emergency procedure

Filming and photography will take place

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SAFE WORK MONTH 2023

Welcome to Country

Robyn Collard and grandson Tryse Rioli

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Minister
Honourable Bill Johnston MLA
Minister for Mines and Petroleum, Industrial Relations

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SAFE WORK MONTH 2023

Progress and challenges in indoor air quality (IAQ) and ventilation

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Professor Dino Pisaniello

School of Public Health
University of Adelaide

Outline

- A history of poor recognition and management of IAQ
- IAQ and ventilation in context
- Is “dilution the solution”? – *the rise of air cleaners*
- Progress in ventilation guidance and standards
- The rise of healthy building verification – *now that’s more like it*
- Benefits versus disbenefits of air cleaners?
- Are there avenues for WHS regulation of IAQ?
- Where to from here? – *the interdisciplinary challenge*

What will and won't be covered

Covered

- The focus will be on office and commercial environments, with some mention of "office-like" healthcare facilities, and home settings
- Indoor environments with mechanical ventilation (eg. HVAC controlled with a BMS)
- Situations where the occupational indoor exposure doesn't fit with the application of a WES (ie. "community-like" settings or infectious aerosols)
- **COVID-19, as our understanding and motivation to deal with IAQ and ventilation has been advanced considerably as a result.**

Possible exception is ozone
WES 0.2 mg/m^3 (peak) and NCC limit is 0.1 mg/m^3 (8hr)

Not covered

- IAQ in industrial facilities (eg. piggeries, recycling plants etc), transportation etc
- Industrial ventilation (capture hoods, LEV, testing and maintenance etc)

History of poor recognition and management of IAQ

Perspectives

Healthy indoor air is our fundamental need: the time to act is now

Inadequate management of indoor air quality may not be obvious, but the disastrous consequences certainly are

According to estimates by the World Health Organization, polluted outdoor air kills over 7 million people annually.[1] In 2021, the WHO published new air quality guidelines to serve as the basis for setting or updating national ambient air quality standards.[2] This document can also be the basis for setting national indoor air standards, as the recommended air pollution levels apply both to outdoor and indoor air. Will national jurisdictions update their indoor air quality (IAQ) standards? The shocking reality is that most countries, including Australia, do not have any IAQ standards or even plans to establish them. The handful of countries that have standards do not have the means and procedures to enforce them; therefore, they do not serve their purpose.[3]

What are the consequences of poor indoor air quality?

The burden of disease due to indoor air pollution in terms of disability-adjusted life-years in 26 European countries was demonstrated in the IAIAQ project.[4] Numerous studies have quantified the negative impact of poor air quality in buildings on health, general wellbeing, and productivity.[5] In Australia, the pre-pandemic costs attributable to respiratory, neurological and other symptoms and illnesses arising from exposure to hazardous gases and particles (both biological and non-biological) in the indoor environment were certainly above the $12 billion per year calculated in a 2001 study.[6]

In addition to pollutants from indoor and outdoor anthropogenic sources, other types of pollutants are those that humans emit. We continuously exhale carbon dioxide (CO_2) and generate particles during all our respiratory activities, at a rate and size dependent on the activity.[7] If pathogens (viruses or bacteria) are present in the respiratory tract, they are emitted as a component of the particles. The predominantly small size of these particles (most of them are < 1 μm) means that they can float in the air for prolonged periods and travel substantial distances within an indoor environment; if a susceptible person inhales these pathogen-laden particles, they can become infected. This process is called airborne transmission of respiratory infections, which the coronavirus disease 2019 (COVID-19) pandemic brought dramatically to our attention.[8] Airborne transmission is considered the dominant mode of transmission of numerous respiratory infections.[9] Of course, this is not a new risk, it has been with us forever, but was not considered, not recognised, and ignored. Globally, before the COVID-19 pandemic, acute respiratory illnesses such as colds and influenza accounted for an annual estimated 300 million lower respiratory infections, resulting in more than 2.7 million deaths and economic losses of billions of dollars.[10] Similar to other countries, viral respiratory infections are a major cause of morbidity and mortality in Australia.[11]

The economic cost of these infections is high; non-influenza respiratory infections cost global communities tens of billions of dollars annually. The estimated cost of acute lower respiratory infections in the European Union totalled €46 billion in 2011;[12] the economic burden from all lower respiratory infections in Australia exceeded $1.6 billion in 2018–19.[13] Although it is unlikely that we could eliminate respiratory infections by controlling airborne transmission in shared indoor spaces, we can substantially reduce them. If hospital admissions occasioned by these diseases could be halved by limiting airborne infections, tens of thousands of Australians would remain healthy, saving hundreds of millions of dollars each year.

Times of crisis expose the limitations of internal atmospheres. Along the Australian south-eastern seaboard in 2019–2020, buildings failed to protect people from bushfire smoke.[14] In the COVID-19 pandemic, countless congregational settings (offices, schools, factories, residential aged care facilities, cruise ships etc), where most of the population spends a substantial fraction of the day working, studying, travelling, enjoying entertainment, resting or undergoing medical care as part of their daily lives, allow virus-laden particles to spread through indoor air.[15] Inadequate management of internal atmospheres might not be obvious, but the disastrous consequences certainly are.

Why is indoor air quality so neglected?

Why is clean indoor air not considered of utmost importance to our health and wellbeing? After all, we spend more than 90% of our lives in buildings, breathing indoor air about 12 times a minute. The

Lidia Morawska[1]
Guy B Marks[2,3]
Jason Monty[4]

1 Queensland University of Technology, Brisbane, QLD.
2 Woolcock Institute of Medical Research, Sydney, NSW.
3 Liverpool Hospital, Sydney, NSW.
4 University of Melbourne, Melbourne, VIC.
l.morawska@qut.edu.au

MJA 217 (11) • 12 December 2022

Podcast with Lidia Morawska available at mja.com.au/podcasts

"Inadequate management of indoor air quality may not be obvious, but the disastrous consequences certainly are"

"Neglected... Because IAQ is a regulatory 'no man's land' "

Morawska L, Marks G and Monty J, Healthy indoor air is our fundamental need: the time to act is now. *MJA*, 217(11), 578 December 2022

This is despite an increasing research interest in IAQ even before the pandemic

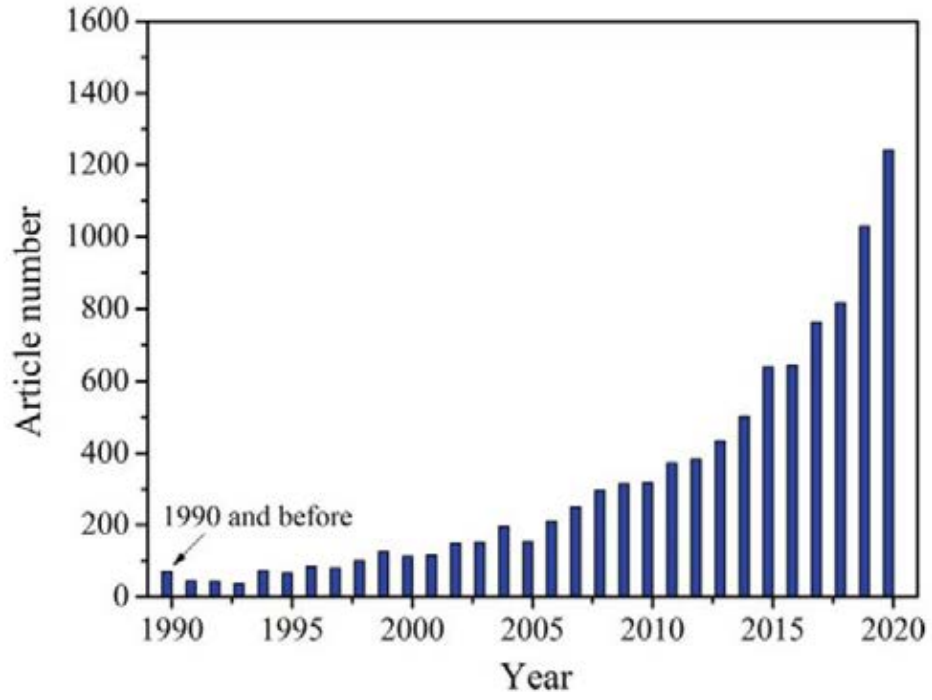


Fig. 1 Evolution of the annual number of peer-reviewed papers on indoor air quality since 1990. (Website: WoS-CC; Keyword: indoor air quality; Document type: articles; Date of analysis: Aug.23, 2021)

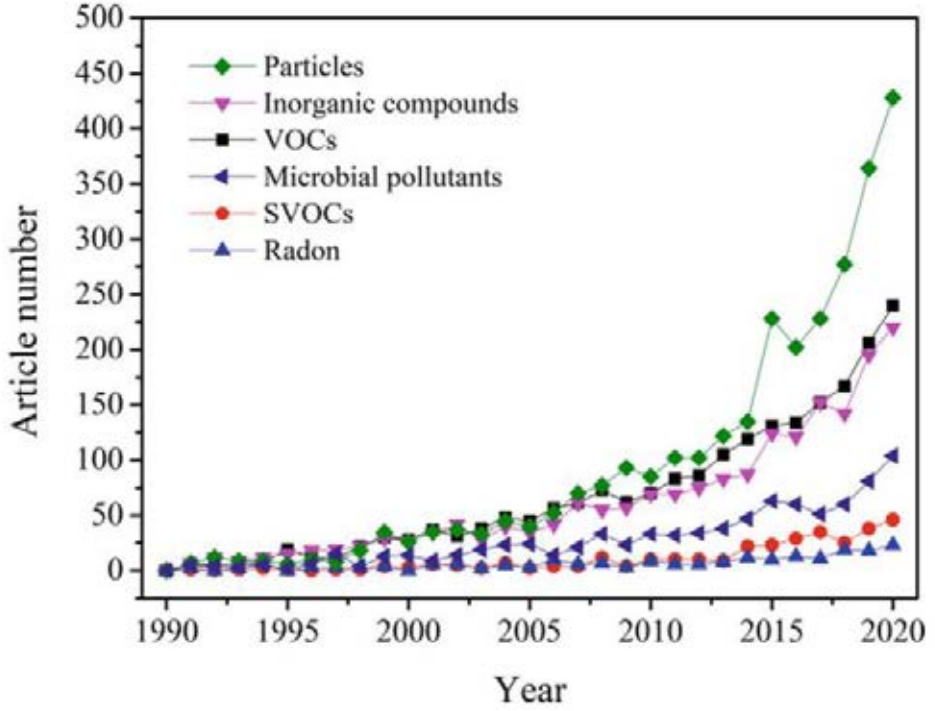


Fig. 2 Evolution of the annual number of peer-reviewed papers related to specific indoor air pollutants since 1990 (Website: WoS-CC; Keyword: "indoor air quality" AND pollutant name; Document type: articles; Date of analysis: Aug.23, 2021)

Y. Zhang et al. (eds.), Handbook of Indoor Air Quality, 2022
https://doi.org/10.1007/978-981-10-5155-5_1-1

Note the recent increase in papers relating to particles

... and that there is compelling evidence that clean air is associated with better health, wellbeing and productivity

…whereas poor IAQ is associated with ill-health

Palacios J, Steele K., Tan, Z. and Zheng S. Human health and productivity outcomes of office workers associated with indoor air quality: a Systematic Review
(July 6, 2021). MIT Center for Real Estate Research Paper No. 21/14

Cognitive performance improves with better IAQ

A Section 508–conformant HTML version of this article is available at http://dx.doi.org/10.1289/ehp.1510037.

Research

Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments

Joseph G. Allen,[1] Piers MacNaughton,[1] Usha Satish,[2] Suresh Santanam,[3] Jose Vallarino,[1] and John D. Spengler[1]

RESULTS: On average, cognitive scores were 61% higher on the Green building day and 101% higher on the two Green+ building days than on the Conventional building day ($p < 0.0001$). VOCs and CO_2 were independently associated with cognitive scores.

CONCLUSIONS: Cognitive function scores were significantly better under Green+ building conditions than in the Conventional building conditions for all nine functional domains. These findings have wide-ranging implications because this study was designed to reflect conditions that are commonly encountered every day in many indoor environments.

Environ Health Perspect 124:805–812 (2016); http://dx.doi.org/10.1289/ehp.1510037

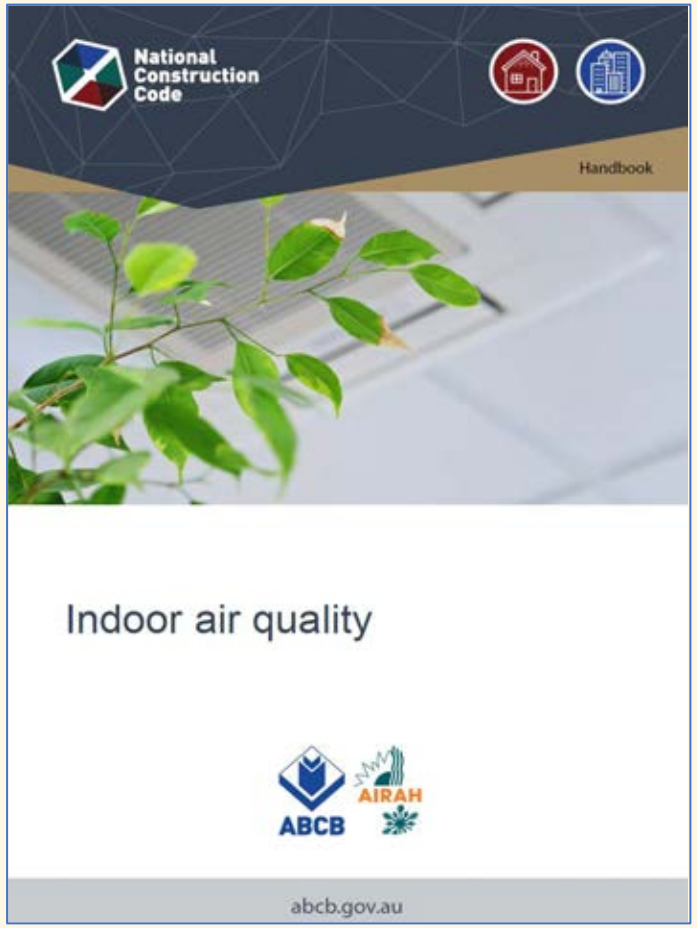
Do we have suitable IAQ criteria?

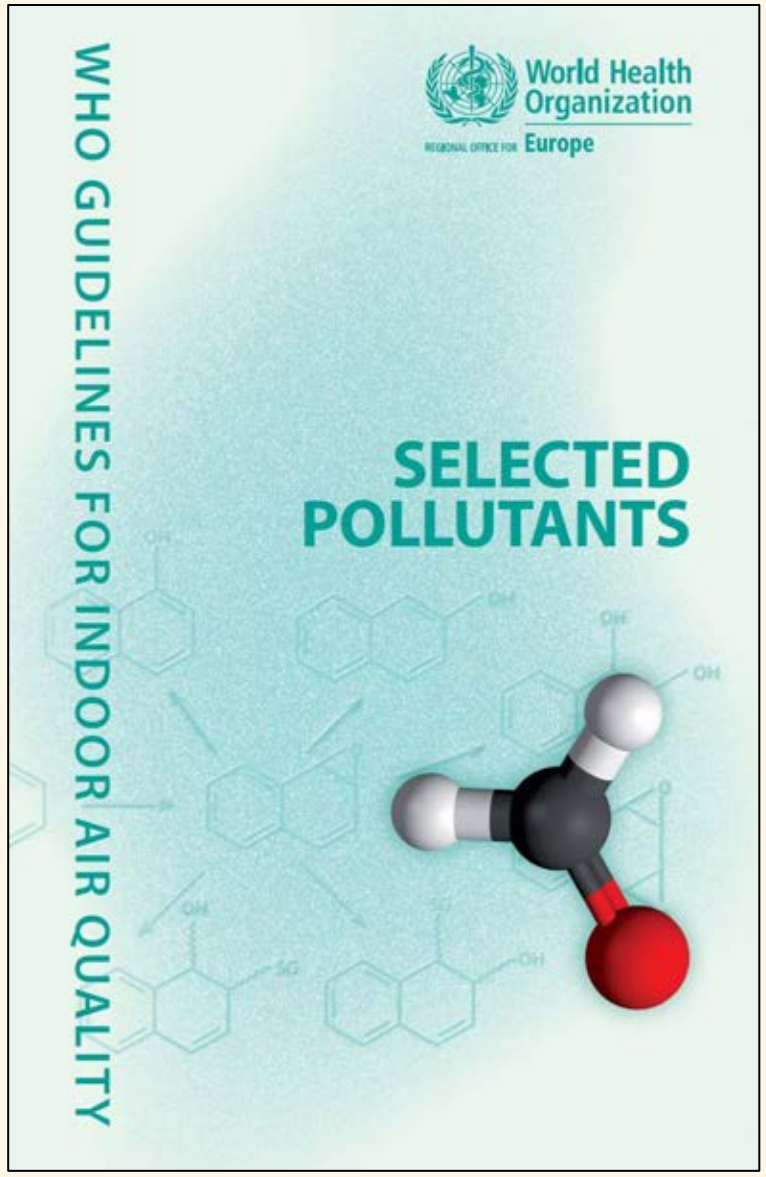
NHMRC recommended Interim National Indoor Air Quality Goals were rescinded in March 2002

Table 2: NHMRC air quality goals for indoor air

Pollutant	Goal concentration	Status
Radon	200 Bq/m^3 (1 year)	Final (action level)
Formaldehyde	100 ppb (ceiling)	Final (residences, schools)
Lead	1.5 µg/m^3 (3 month)	Interim
Carbon monoxide	9 ppm (8 hour)	Interim
Nitrogen dioxide	—	Under review
Total volatile organic compounds	500 µg/m^3 (1 hour)	Level of concern
Single volatile organic compounds	⩽50% Total volatile organic compounds	Level of concern
Sulphates	15 µg/m^3 (1 year)	Interim
Sulphur dioxide	500 ppb (10 minute) 250 ppb (1 hour) 20 ppb (1 year)	Interim Interim Interim
Total suspended particulates	90 µg/m^3 (1 year)	Interim
Ozone	120 ppb (1 hour)	Interim

TVOC value still being used in the NCC IAQ Handbook





Maybe for some and it varies by country

Table 1. Pollutants considered for inclusion in the WHO indoor air quality guidelines by the WHO working group in October 2006

Group 1. Development of guidelines recommended	Group 2. Current evidence uncertain or not sufficient for guidelines
Benzene	Acetaldehyde
Carbon monoxide	Asbestos
Formaldehyde	Biocides, pesticides
Naphthalene	Flame retardants
Nitrogen dioxide	Glycol ethers
Particulate matter ($PM_{2.5}$ and PM_{10})	Hexane
Polycyclic aromatic hydrocarbons, especially benzo-[*a*]-pyrene	Nitric oxide
Radon	Ozone
Trichloroethylene	Phthalates
Tetrachloroethylene	Styrene
	Toluene
	Xylenes

Source: WHO Regional Office for Europe *(5)*.

2010

ISIAQ STC 34 has developed a database to share worldwide IEQ guidelines

Should we use outdoor air quality criteria instead?

WHO global air quality criteria 2021

Collectively, there is sufficient evidence to conclude that there is no safe threshold for exposure to PM_{10}, $PM_{2.5}$ or lead. For NO_2, there is a threshold, but the current NEPM standard is well above this level. On this basis, current standards are not sufficient to adequately protect the health of the Australian community

Zosky GR et al. Med J Aust. 2021 Apr;214(6):254-256.e1.

IAQ and ventilation in context

*OK - staff sometimes complain about stuffiness and odd smells, but the building manager hasn't **told** me of any IAQ issues in our building – addressing IAQ is their problem isn't it?*

"Today, healthy buildings are not really 'healthy' buildings but rather 'not-sick' buildings. We know much about the effects of many targeted indoor air pollutants on human health. However, we know little about the effects related to improving indoor air quality on improving health"

Y. Zhang et al. (eds.), Handbook of Indoor Air Quality, 2022
https://doi.org/10.1007/978-981-10-5155-5_1-1

And BTW is a sterile office healthy?

Healthy microbiome

Bruno A, Fumagalli S, Ghisleni, G. and Labra, M. 2022, 'The microbiome of the built environment: The nexus for urban regeneration for the cities of tomorrow'. *Microorganisms*, vol. 22, no. 10, part 12, p. 2311.

Stanhope J, Breed M and Weinstein P. Re-assessment of the hygiene hypothesis. Biodiversity, Microbiomes, and Human Health https://link.springer.com/chapter/10.1007/978-3-030-91051-8_3

Indoor air quality

IAQ is a measure or an analysis of the condition of air in an enclosure (a room) and it includes the physical, chemical and microbiological makeup of the air within and around buildings and structures, especially as it relates to the health and comfort of building occupants.

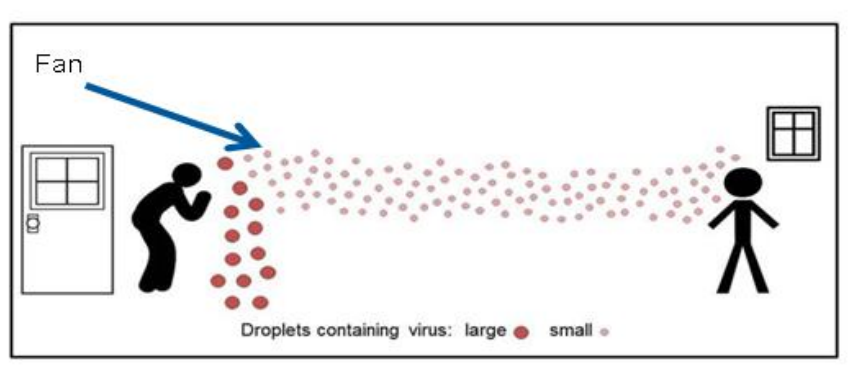
National Construction Code - Handbook: Indoor air quality (2021)

Adding the term “adequate” or “acceptable” to IAQ adds an additional level of complexity to the analysis, as the expected subjective response of people to the air now needs to be measured or approximated. Acceptable IAQ includes health and comfort considerations.

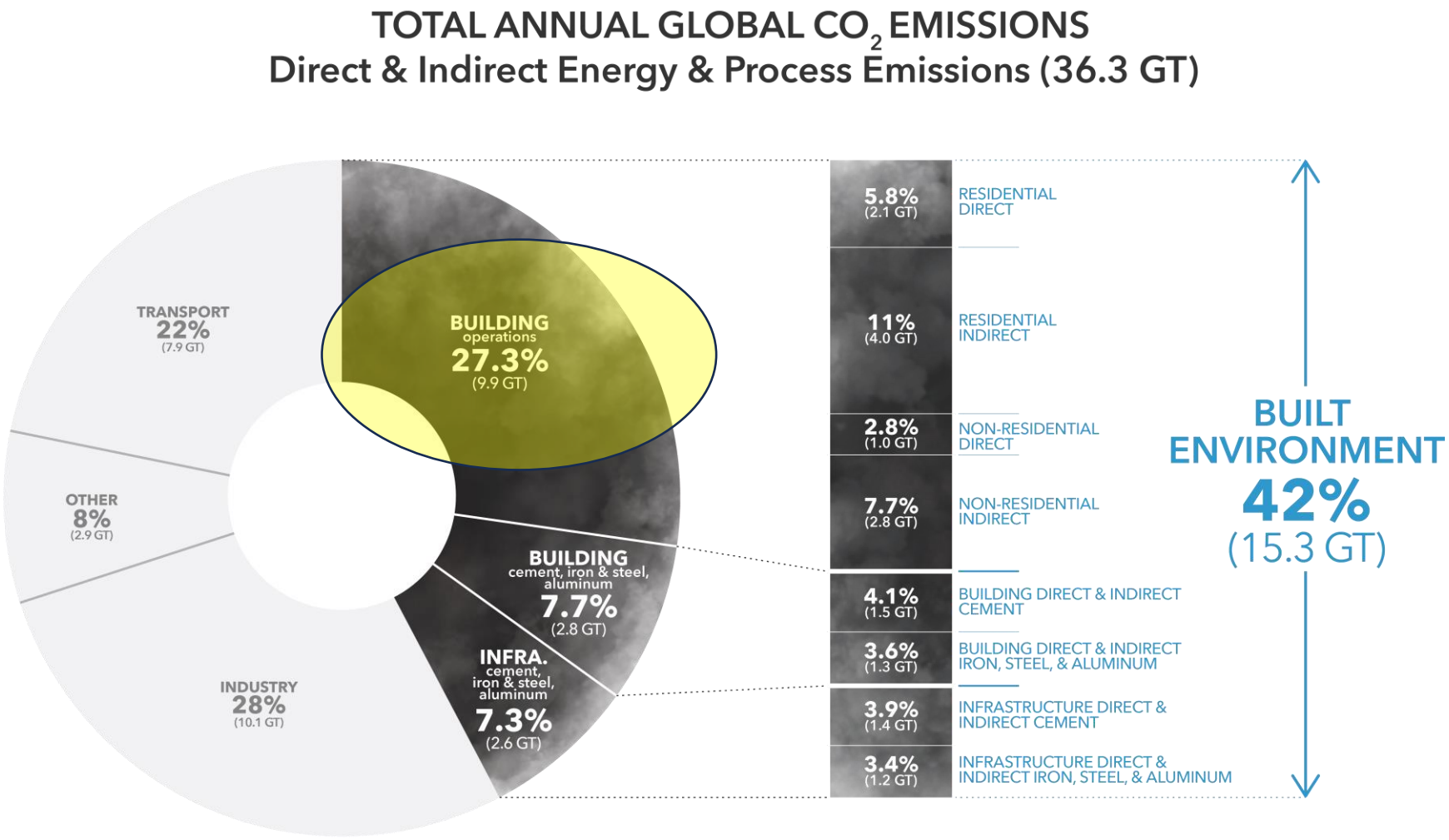
ISO 16814 contains the following definition of Acceptable IAQ: Air in an occupied space toward which a substantial majority of occupants express no dissatisfaction and that is not likely to contain contaminants leading to exposures that pose a significant health risk (ISO 2016).

Ventilation

- Ventilation can reduce health risk by reducing indoor air pollutant concentrations.
- Ventilation entails taking in air from another space (hopefully clean fresh air) and exchanging it. Hence, the rate of ventilation can be expressed as air changes per hour (ACH) for the room or L/s for each person. Mechanical ventilation involves a fan.
- Ventilation is not simply air movement.
- Poorly directed air movement can increase exposures, dry membranes or do nothing.



Air conditioning and mechanical ventilation in buildings is energy intensive



Analysis & Aggregation by Architecture 2030 using data sources from IEA & Statista.

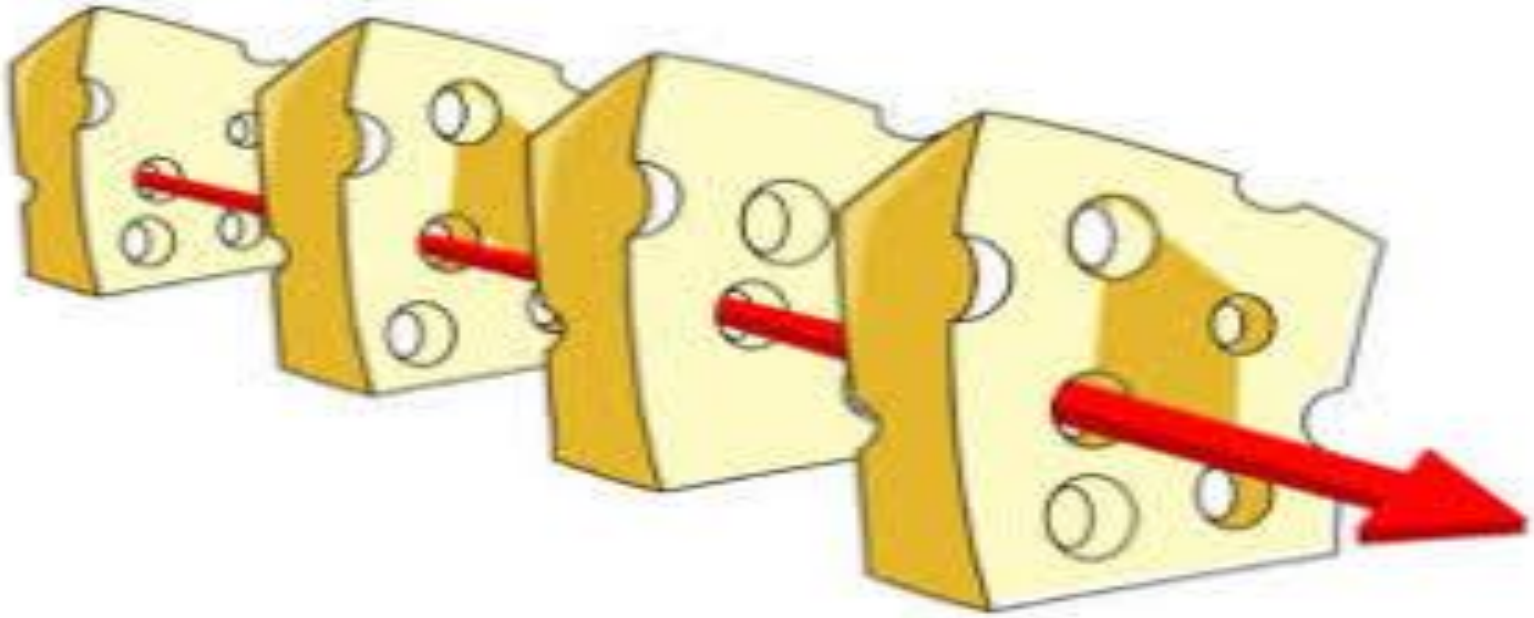
Ventilation is only one layer in a multilayered approach to indoor environment management

Elimination and Isolation

Engineering controls

Administrative controls

PPE



Layering is according to the hazard control hierarchy

Reality check: Did these controls work for the COVID-19 pandemic?

Issued: August 2023 DES8417_1
ISBN: 978-1-78252-671-1

Non-pharmaceutical interventions:

- **Travel and border restrictions (Elimination and Isolation)**
- **Social distancing and Lockdowns (Isolation)**
- **Test, trace and isolate (Isolation)**
- **Environmental controls (Engineering controls)**
- **Communications (Admin controls)**
- **Masks and face coverings (PPE)**

The review found evidence that enhanced ventilation, air treatment to remove infectious virus and reduced room occupancy did reduce transmission within particular settings. However, the studies were unable to control fully for possible confounding factors.

Is “dilution the solution”? – *the rise of air cleaners*

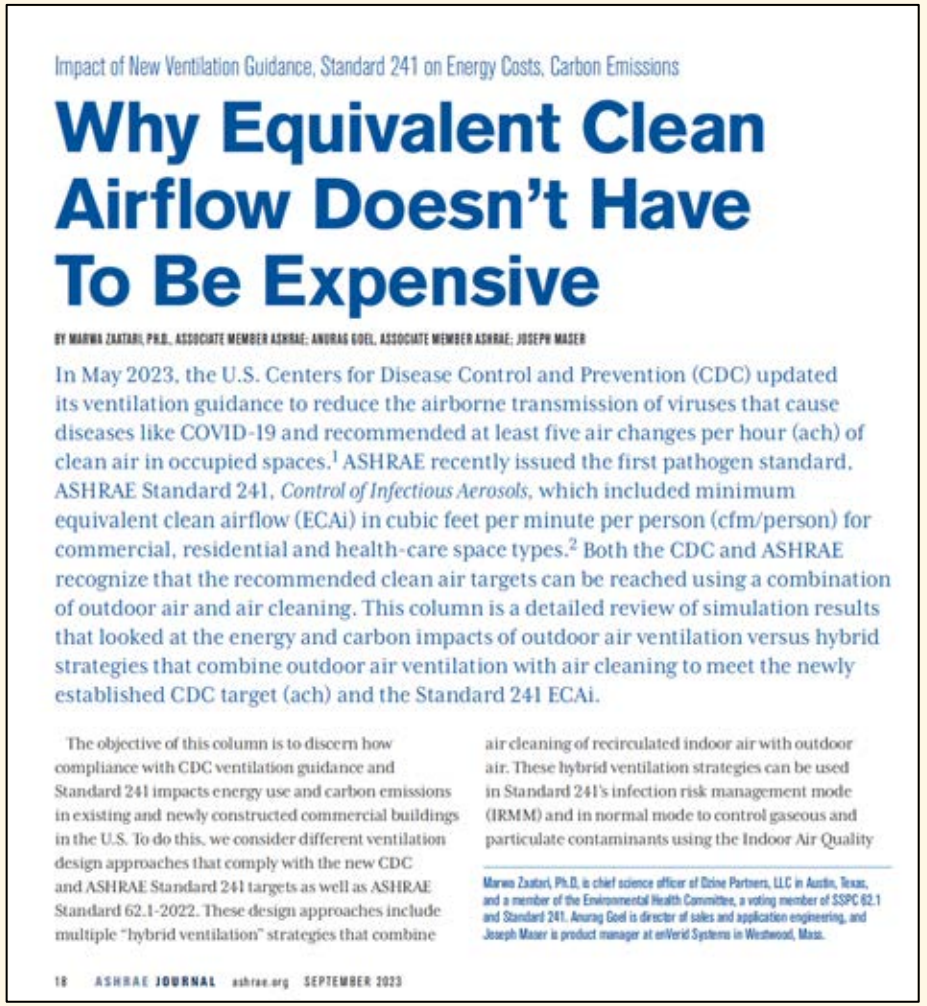
Yes – a solution, provided the diluent air meets the criteria for acceptable air quality (including temperature and humidity)

However, air cleaners can provide “equivalent” clean air, that supplements the outside diluent air.

Portable air cleaners/purifiers are popular, and used in situations where outside air supply is limited or questionable, or occupancy is high increasing the risk of airborne viral transmission, especially with vulnerable persons.

Air cleaners integrated into HVAC systems have additional benefits, and the equivalent clean air flow can meet new guidelines for enhanced ventilation.

In principle, both types of air cleaner can mitigate air contaminants coming from outside (eg. bushfire smoke) or internally generated contaminants.



Impact of New Ventilation Guidance, Standard 241 on Energy Costs, Carbon Emissions

Why Equivalent Clean Airflow Doesn't Have To Be Expensive

BY MARWA ZAITARI, PH.D., ASSOCIATE MEMBER ASHRAE; ANURAG GOEL, ASSOCIATE MEMBER ASHRAE; JOSEPH MAIER

In May 2023, the U.S. Centers for Disease Control and Prevention (CDC) updated its ventilation guidance to reduce the airborne transmission of viruses that cause diseases like COVID-19 and recommended at least five air changes per hour (ach) of clean air in occupied spaces.[1] ASHRAE recently issued the first pathogen standard, ASHRAE Standard 241, *Control of Infectious Aerosols*, which included minimum equivalent clean airflow (ECAi) in cubic feet per minute per person (cfm/person) for commercial, residential and health-care space types.[2] Both the CDC and ASHRAE recognize that the recommended clean air targets can be reached using a combination of outdoor air and air cleaning. This column is a detailed review of simulation results that looked at the energy and carbon impacts of outdoor air ventilation versus hybrid strategies that combine outdoor air ventilation with air cleaning to meet the newly established CDC target (ach) and the Standard 241 ECAi.

The objective of this column is to discern how compliance with CDC ventilation guidance and Standard 241 impacts energy use and carbon emissions in existing and newly constructed commercial buildings in the U.S. To do this, we consider different ventilation design approaches that comply with the new CDC and ASHRAE Standard 241 targets as well as ASHRAE Standard 62.1-2022. These design approaches include multiple "hybrid ventilation" strategies that combine air cleaning of recirculated indoor air with outdoor air. These hybrid ventilation strategies can be used in Standard 241's infection risk management mode (IRMM) and in normal mode to control gaseous and particulate contaminants using the Indoor Air Quality

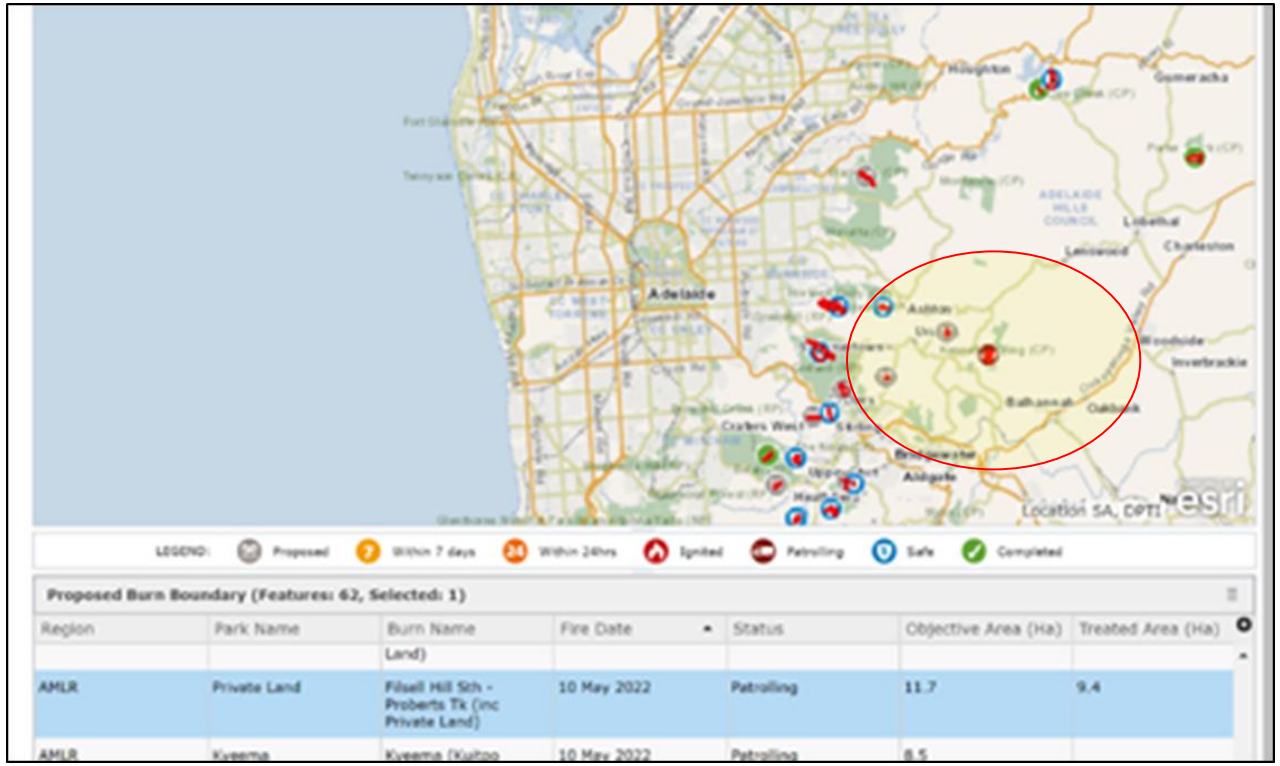
Marwa Zaitari, Ph.D., is chief science officer of Dzine Partners, LLC in Austin, Texas, and a member of the Environmental Health Committee, a voting member of SSPC 62.1 and Standard 241. Anurag Goel is director of sales and application engineering, and Joseph Maier is product manager at enVerid Systems in Westwood, Mass.

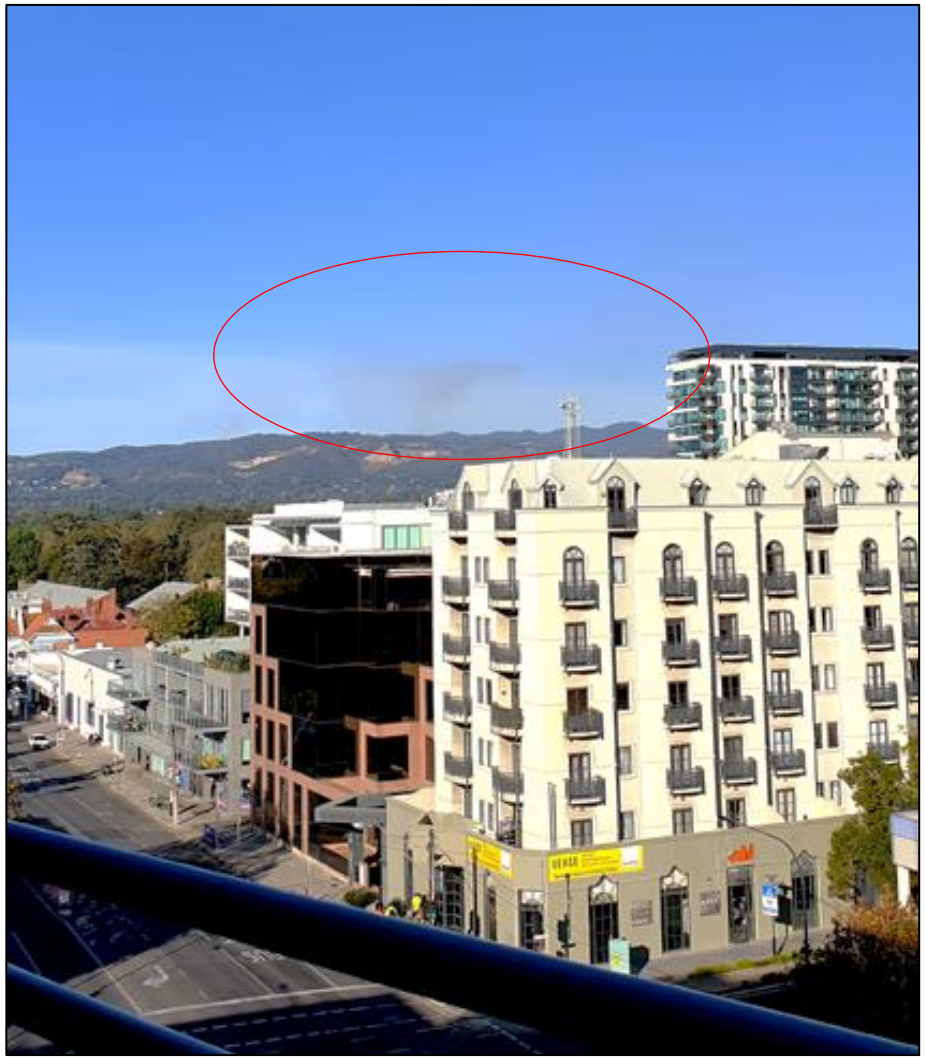
Case study 1

PlasmaShield air cleaner in an unoccupied office building

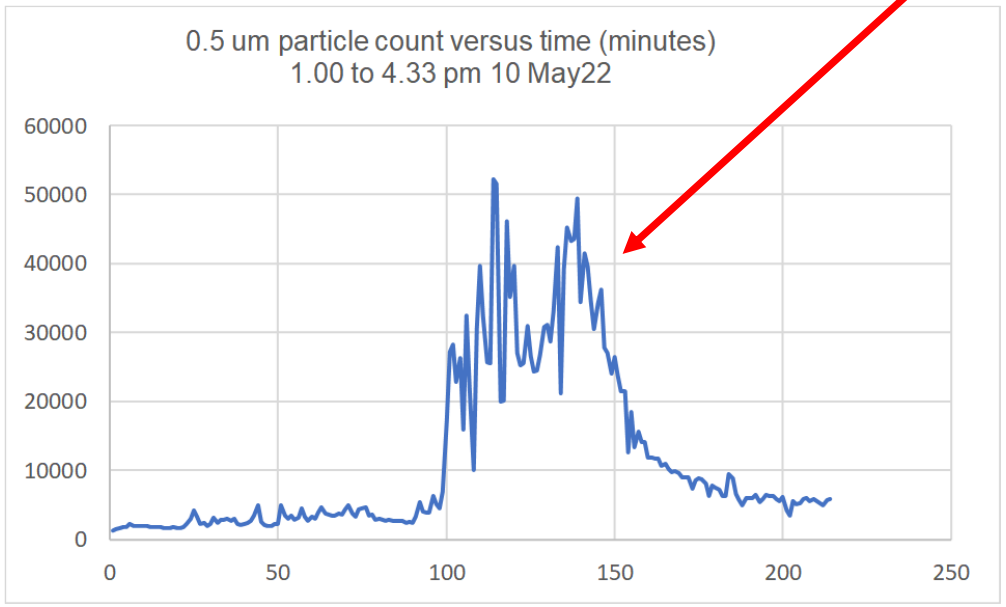
The PlasmaShield evaluation demonstrated particle reductions of 90 - 95%.

During the testing a short-term smoke event was noted, namely a Country Fire Service prescribed burn.

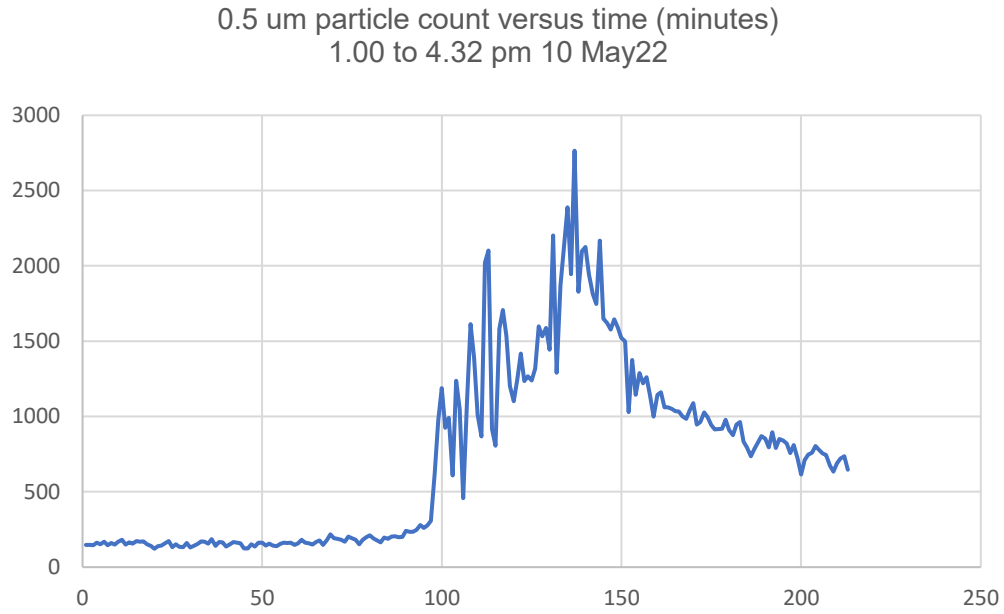




Case study 1 (cont.)



Air Inlet particle numbers versus time



Outlet particle numbers versus time
(NOTE y axis about 20 times less)

The 0.5 µm size range was selected on the basis of human exhalation studies (Archer et al, 2022), and the size range most problematic for particle filters.

Case study 2: Residential setting

public health research&practice
A JOURNAL OF THE SAX INSTITUTE

July 2023; Online early
https://doi.org/10.17061/phrp33232307
www.phrp.com.au

Research

Evaluating portable air cleaner effectiveness in residential settings to reduce exposure to biomass smoke resulting from prescribed burns

Amanda J Wheeler[a,b,c,h], Fabienne Reisen[a], Christopher T Roulston[a], Martine Dennekamp[d,e], Nigel Goodman[f,g] and Fay H Johnston[b]

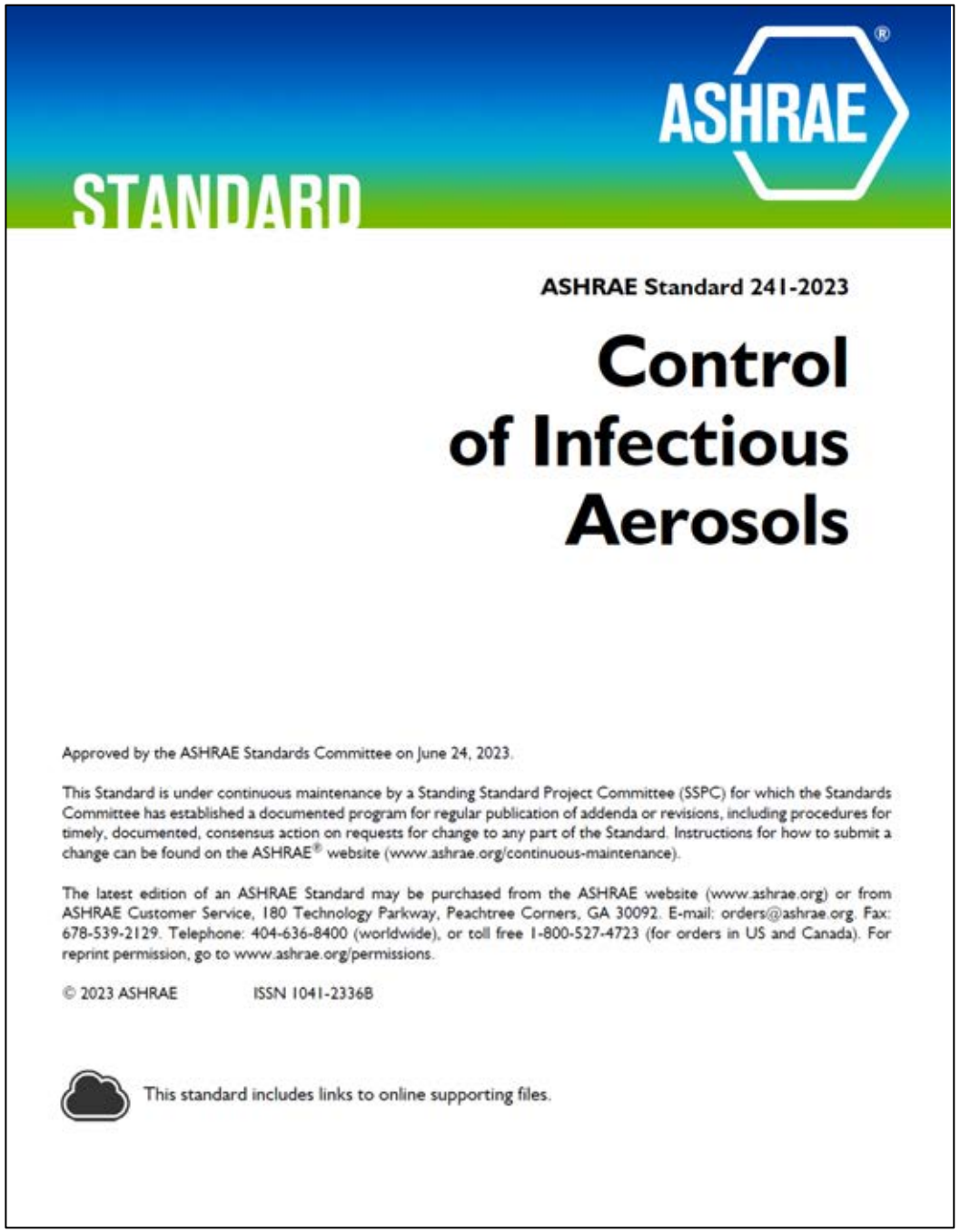
Winix ZERO+ PRO 5-stage Air Purifier

Clean air delivery rate: 470m³ per hour

Methods: We provided 10 homes from semirural regions of Victoria, Australia, with HEPA cleaners and conducted continuous monitoring of indoor and outdoor fine particulate matter ($PM_{2.5}$) for 2–4 weeks during prescribed burning periods. We calculated the potential improvements to indoor air quality when operating a HEPA cleaner during a smoke episode. Ventilation measures were conducted to identify points of smoke ingress and housing characteristics that could lead to higher infiltration rates.

Results: Depending on the house, the use of HEPA cleaners resulted in a reduction in indoor $PM_{2.5}$ concentrations of 30–74%.

Progress in ventilation guidance and standards



ASHRAE Standard 241 - 2023 “Control of Infectious Aerosols” addresses the control of “infectious far-range aerosols” and thus reduce the risk of disease transmission indoors. It specifically refers to an “Infection Risk Management Mode” (IRMM) which can be implemented when required to deal with increased risk of airborne disease transmission.

ASHRAE 241 essentially proposes two strategies to deliver IRMM, namely a range of increased outside air flowrates (depending on the application), or criteria for decontaminating return air as a proportional alternative to “clean” outside air.

How Much Ventilation Is Enough?

Aim for 5 Air Changes per Hour (ACH)

> When possible, aim for 5 or more air changes per hour (ACH) of clean air to help reduce the number of germs in the air.

This can be achieved through any combination of central ventilation system, natural ventilation, or additional devices that provide equivalent ACH (eACH[†]) to your existing ventilation. Supplying or exhausting an amount of air (use the larger of the two values but do not add them together) that is equal to all the air in a space is called an air change. Multiplying that amount by 5 and delivering it over one hour results in 5 ACH.

The rise of healthy building verification

- *now that's more like it*

Case Study 3 – Application of a Systematic Approach to IAQ

- Mt Barker Medical Clinic was the first healthcare building in Australia to be recognised with UL Verified Healthy Building accreditation for IAQ.
- Uses PlasmaShield air filtration technology.
- Underwent a verification process initially, with on site visits, and developed policies and plans.
- To maintain verification, surveillance will continue twice a year.

Better Medical

Adelaide Hills Medical Clinic Stirling
2 Johnston Street
Stirling SA 5152
P 8339 4344
F 8339 2979

Bridgewater Medical Clinic
3/399 Mount Barker Rd
Bridgewater SA 5155
P 8339 2077
F 8339 6483

Mt Barker Medical Clinic
Suite 1 Ground Floor
15-19 Victoria Crescent
Mt Barker SA 5251
P 8391 1300
F 8398 3913

Strathalbyn Family Medical Centre
33 High Street
Strathalbyn SA 5255
P 8536 4466
F 8536 4488

Mt Barker South Medical Centre
58 Wellington Road
Mount Barker SA 5251
P 8391 2055
F 8391 5342

Hahndorf Medical Clinic
43a Mount Barker Road
Hahndorf SA 5245
P 8388 7066
F 8388 7415

Indoor Air Quality Management Plan

Hills Medical Pty Ltd T/A: Better Medical

Mt Barker Medical Clinic

1. Revision History

Revision 01 – March 23, 2023

2. Purpose

Hills Medical Pty Ltd strives to provide all building occupants with an environment that maintains acceptable indoor air quality. The Indoor Air Quality (IAQ) Management Plan is designed to protect the health and safety of building occupants and decrease exposure to indoor air contaminants.

All employees are required to follow the procedures outlined in this plan. Any deviations from this plan must be immediately brought to the attention of the Program Administrator.

3. Scope

This plan applies to Mt Barker Medical Clinic at 15-19 Victoria Cres, Mount Barker SA 5251 occupied by Hills Medical Pty Ltd employees. The plan outlines Mt Barker Medical Clinic's response to IAQ reports, building maintenance standards and employee communications.

Contents

Other requirements

- Mould and Moisture Response Plan;
- Preventative Maintenance Plan; and
- Hazardous Materials Management Plan (only needed if asbestos or other identified hazardous building materials exist)

How is this different?

- Driven by an external party, requiring a specific and holistic policy and signoff by an IAQ manager for the site.
- Verification notice at entrance to inform patients.
- Staff are trained, e.g. reporting and investigation process.
- Staff instructed not to use pesticides, air fresheners, bring in animals etc..
- IAQ-related contractors are specified in advance (e.g. cleaners and cleaning schedule).
- Airflow patterns in occupied zones assessed.
- Real time sensors can be included and interrogated.

Benefits versus disbenefits of air cleaners?

National Collaborating Centre for Environmental Health (https://ncceh.ca/)
Centre de collaboration nationale en santé environnementale

Health Benefits vs. Disbenefits from Indoor Air Cleaners

Register Now

Location Type

Online

Date & Time

From: August 2, 2023, 10am (PT)

To: August 2, 2023, 11:30am (PT)

Hosted by the US EPA

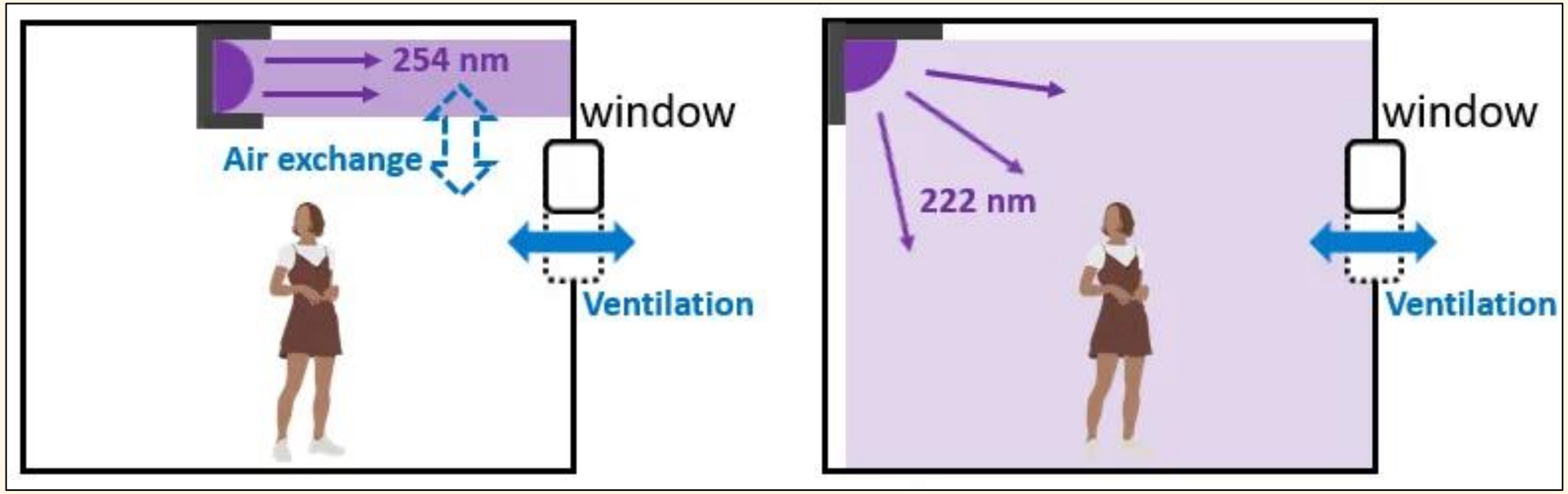
The COVID-19 pandemic has led to a large increase in the commercialization of air cleaners. Some air cleaners work based on filtering (e.g., HEPA filters or low-cost Corsi-Rosenthal boxes). Other types work based on chemical reactions or ultraviolet light that change pathogen molecules and render them non-infective.

Some air cleaners produce ozone or particulate matter, which can degrade indoor air quality. In this presentation we will examine these types of air cleaners and compare the estimated reduction in mortality due to reduced airborne disease transmission (COVID-19 and flu) with the estimated increase in mortality due to degradation of indoor air quality. Several sensitivity studies will be presented for a range of situations.

Featured Speaker: Jose-Luis Jimenez, Ph.D., University of Colorado-Boulder Jose-Luis Jimenez, Ph.D., is a Distinguished Professor of Chemistry and Fellow of CIRES at the University of Colorado-Boulder. He earned his Ph.D. at MIT in Mechanical Engineering in 1999 and his MS at the Univ. of Zaragoza (Spain) and Univ. of Compiegne (France) in 1993. His research group focuses on advanced real-time aerosol and gas composition measurements, as well as computer modeling. He is a 2014-2022 Highly Cited Researcher, and a Fellow of the AAAR and the AGU. Since the pandemic he has been investigating airborne transmission, including its dynamics, prevention, and history.

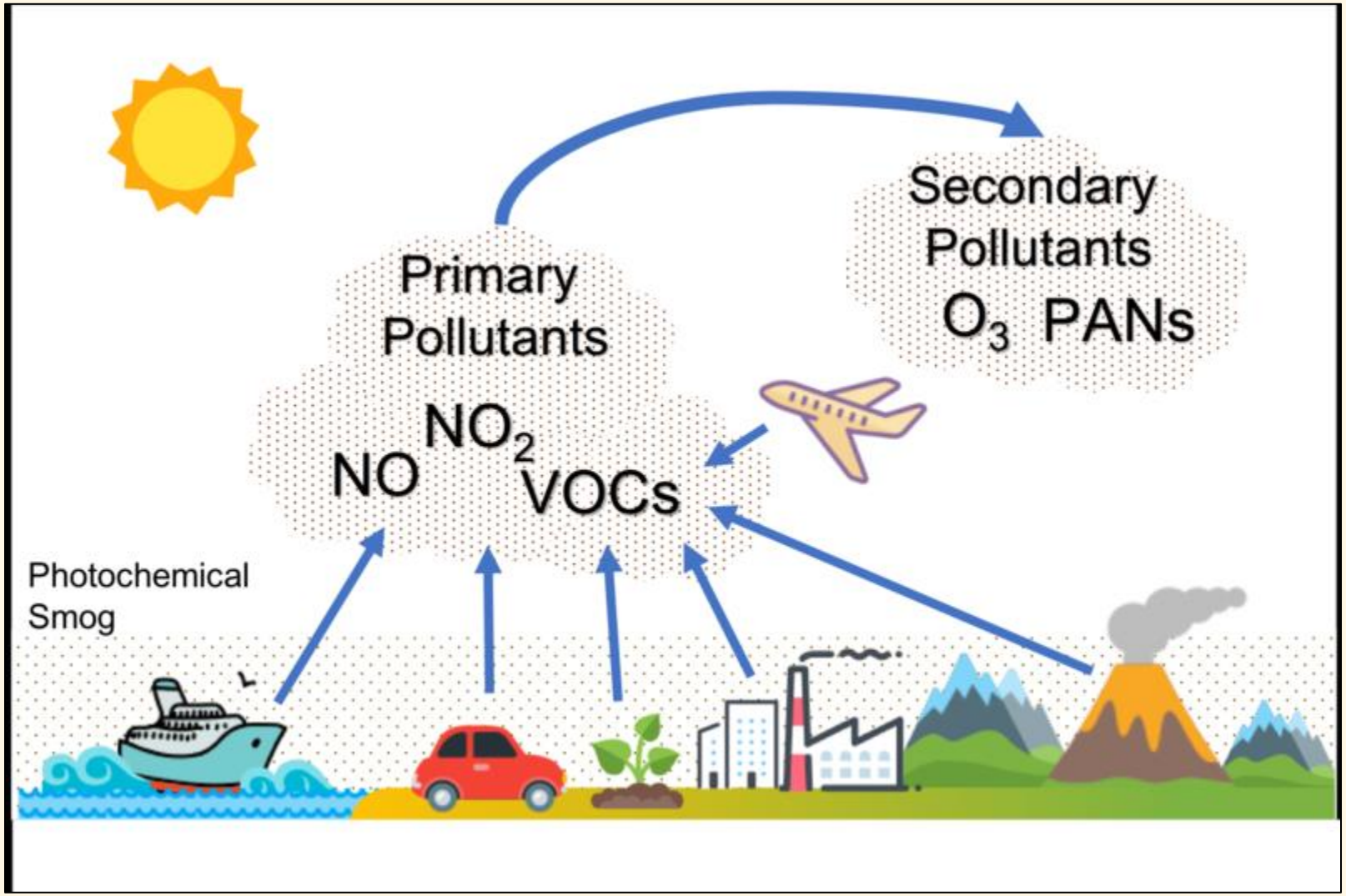
It has been argued by Professor Jose Jimenez and colleagues that ozone-generating indoor UV and “ionisation”- style air cleaners can contribute to an invisible indoor smog, especially in the presence of certain terpene-containing air fresheners or cleaning products.

Photochemical smog is associated with increased mortality. Thus, there may be a disbenefit associated with some air cleaners.

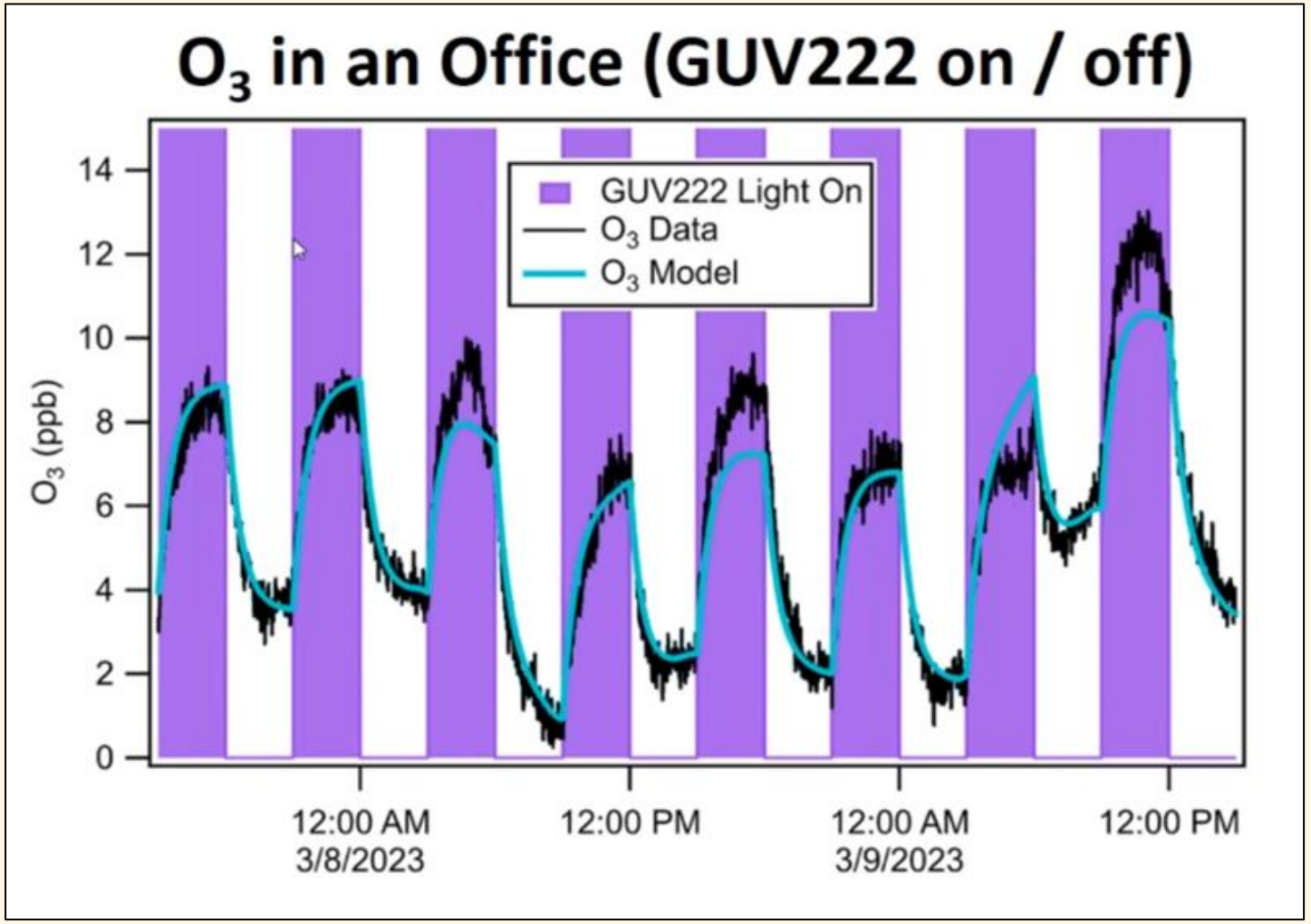


Air disinfection with UV

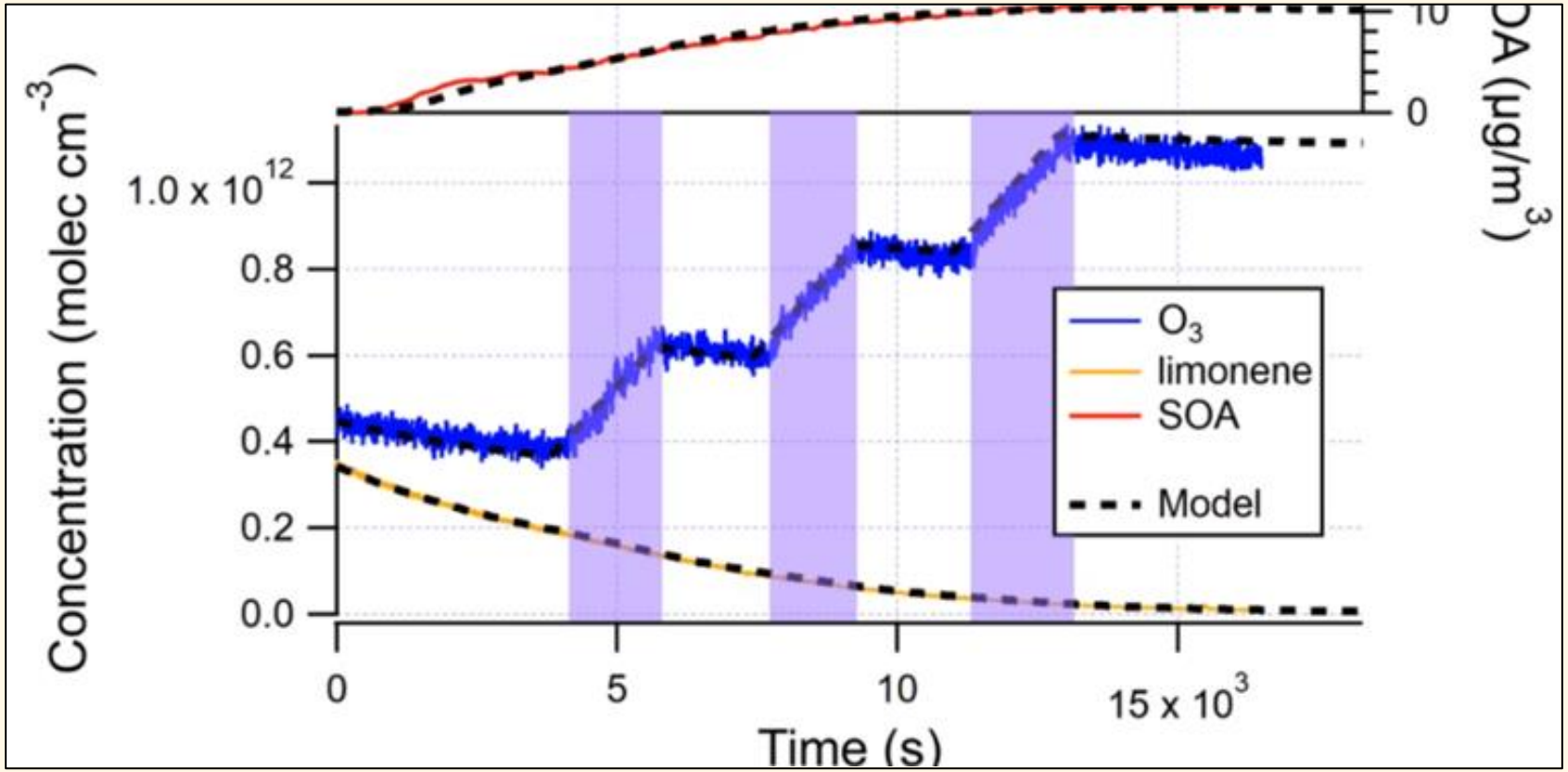
Upper-level UV irradiation (254 nm) and Direct irradiation (222 nm)



UV plus indoor VOCs can lead to secondary pollutants – ozone and toxic organic particles



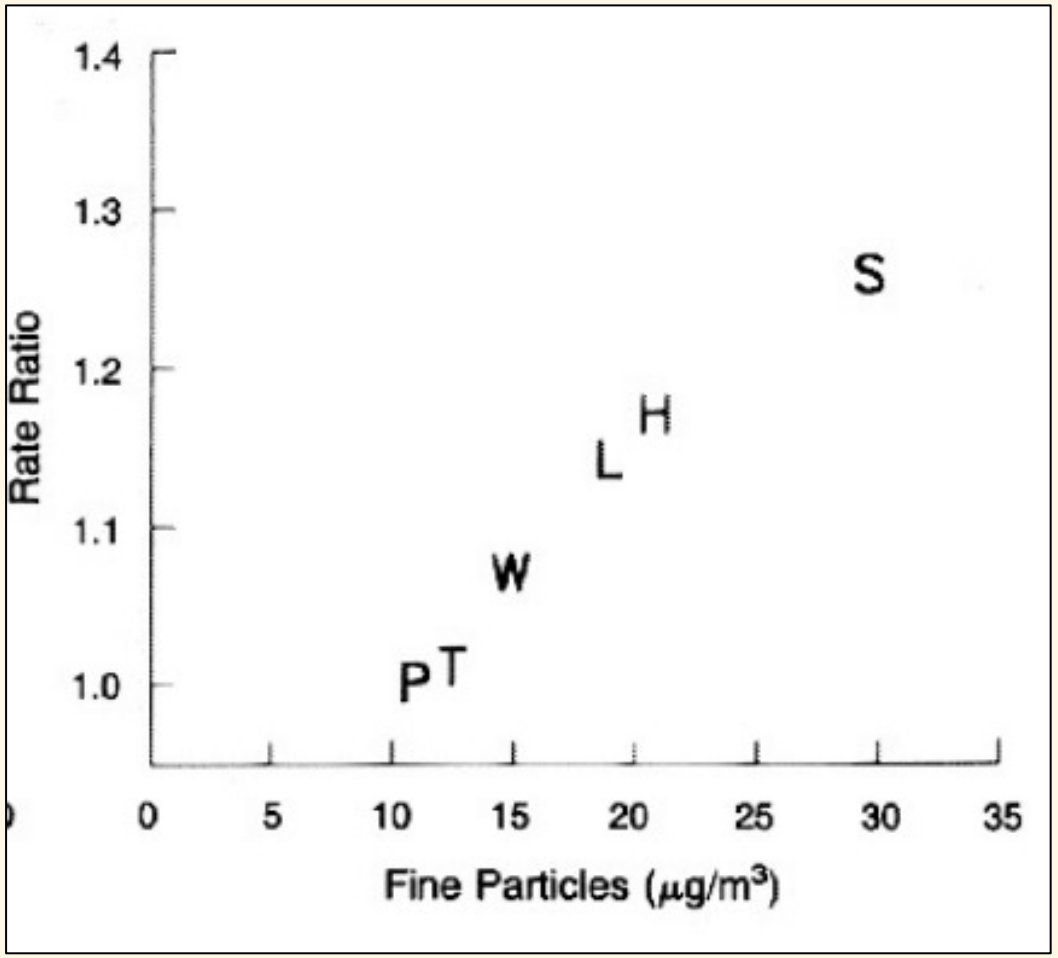
ROOM EXPERIMENT (Peng and Jimenez, 2023)



CHAMBER EXPERIMENT (Peng and Jimenez):

Formation of particles from common cleaning agent in the presence of ozone

Limonene + Ozone → particles



Mortality from air pollution
(Harvard six cities study)

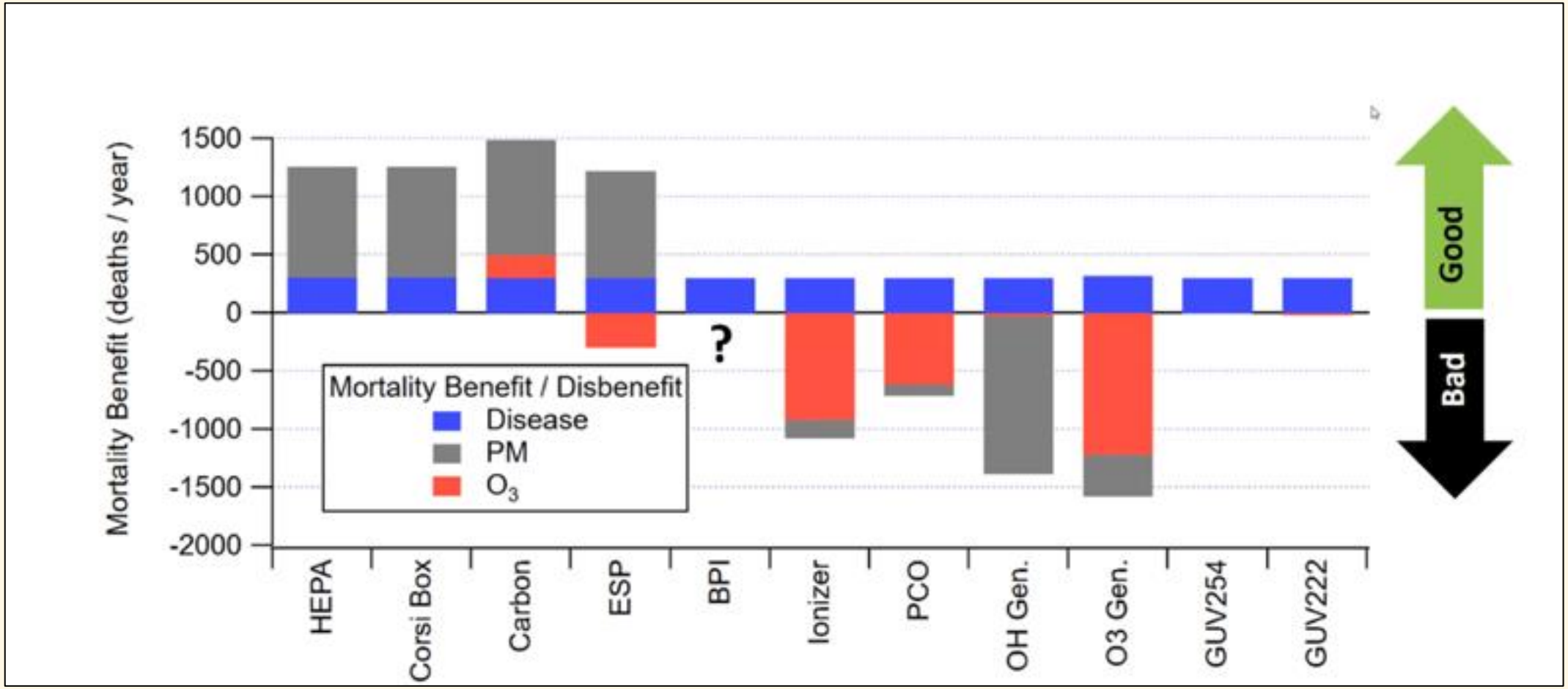
University of Colorado Boulder

Air Cleaners

√: deaths avoided
X: deaths caused

Air Cleaner Technology	Disinfects Air?	Helps or Hurts w/ Pollution?
HEPA, CR-Box, MERV13 Filters	√	√
Activated Carbon Filters	√	√
Electrostatic Precipitators	√	X √
O_3 Generators	√	X
OH Generators	√	X
Photocat. Oxidation (PCO)	√	X
HOCl / H_2O_2 Foggers	√	X
Ionizers	√	X
Bipolar Ionizers	√	Neither or X
Germicidal UV at 222 nm	√	X
Germicidal UV at 254 nm	√	X

Benefits and disbenefits of various air cleaners
(mathematical models, with simplistic assumptions)



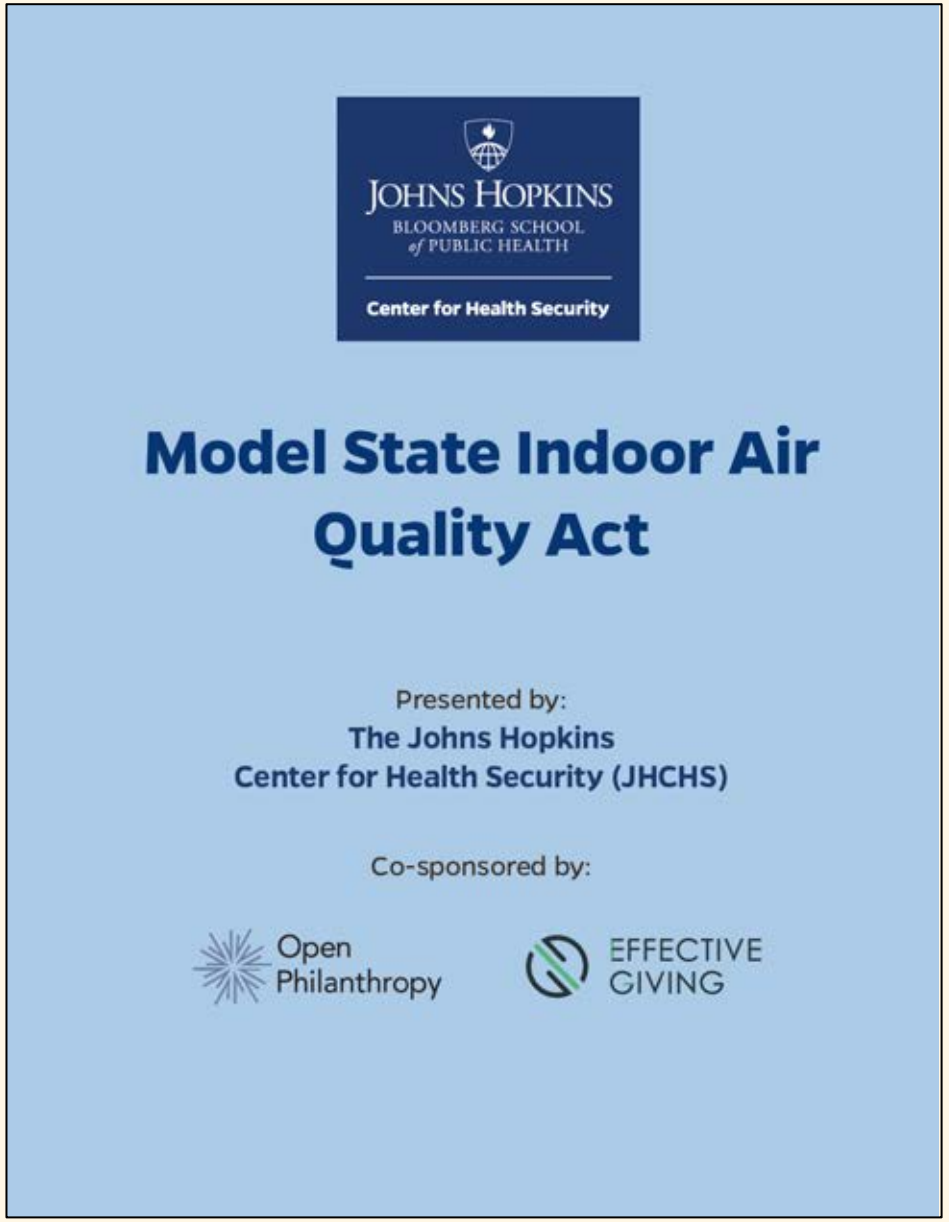
Overall air cleaner comparison – Pandemic conditions (Jimenez 2023)

Are there avenues for WHS regulation of IAQ?

Advocate for specific legislation

Indoor Air Roundtable in the Federal Parliament (August 2023)

Target building owners with legal requirements on IAQ?



Proper ventilation and filtration in crowded public indoor settings can significantly reduce the costs of illness at a benefit-cost ratio ranging from 3:1 to 100:1, exceeding similar ratios for most other public health interventions (Zafari et al, 2022).

The Model State Indoor Air Quality Act (MSIAQA) is intended to be adapted and adopted by state legislatures as a legal framework for good IAQ in **public spaces**, outlining best practices for how to monitor implementation, inform the public about the quality of indoor air and the benefits of good IAQ, adjust acceptable standards based on the latest research from expert bodies, and **seek compliance among building owners.**

OSHA guidance outlined indoor air pollutant sources, prevention, and control measures, but **a comprehensive rule proposed by OSHA to regulate IAQ nationally was jettisoned in December 2001** (Federal Register 66:64946).

Zafari et al.Cost Effectiveness and Resource Allocation (2022) 20:22 https://doi.org/10.1186/s12962-022-00356-1

Can we leverage the progress in building design and verification via due diligence requirements of WHS legislation?

https://www.safeworkaustralia.gov.au/system/files/documents/1812/officer-duty-interpretive-guide.pdf

safe work australia

THE HEALTH AND SAFETY DUTY OF AN OFFICER

Section 27 of the model Work Health and Safety (WHS) Act places a duty on an officer of a person conducting a business or undertaking (PCBU) to exercise due diligence to ensure that the PCBU complies with their duties or obligations under the model WHS Act. This document sets out who is an officer and what the officer duty requires of them.

2.2. Due diligence

Section 27(5) of the model WHS Act clarifies that due diligence involves taking reasonable steps:

1. to acquire and keep up-to-date knowledge of WHS matters

   (for example, knowledge of WHS laws, approved Codes of Practice relevant to the business or undertaking, the principles of managing WHS risks, industry standards and practice, and the possible strategies and processes for elimination or minimisation of hazards and risks relevant to the work being carried out);

2. to gain an understanding of the nature of the operations of the business or undertaking of the PCBU and generally of the hazards and risks associated with those operations

   (advice from a suitably qualified person may be required to gain a general understanding of the hazards and risks associated with the operations of the business or undertaking);

Can a due diligence index be adapted to encompass healthy buildings?

The (DDI-S) has been developed to provide a metric for boards and executives of organisations to understand the presence of safety in their organisation by collecting and reporting on the state of assurance activity being taken at the organisational level.

International Labour Review, Vol. 161 (2022), No. 3

A capacity index to replace flawed incident-based metrics for worker safety

Sidney W.A. DEKKER* and Michael TOOMA**

Abstract. *The shortcomings of incident-based metrics for worker safety such as total recordable incident frequency rate (TRIFR) are well documented. In particular, a low TRIFR is no assurance against legal liability. There is considerable overlap between the literature on safety as the presence of capacities to make things go well, and jurisprudence in labour and workplace safety law on employer due diligence. In this article, the authors propose an index that merges the two, measuring the capacities to acquire and maintain safety knowledge, to understand the nature of operations, to resource for safety, to respond to risks, to demonstrate engagement and compliance, and for assurance.*

In the light of the above, the index proposed in this article comprises the following six capacities and indicator capabilities:

(i) *the capacity to acquire and maintain safety knowledge*, tracking capacity-building so that things go well even under variable conditions (Know);

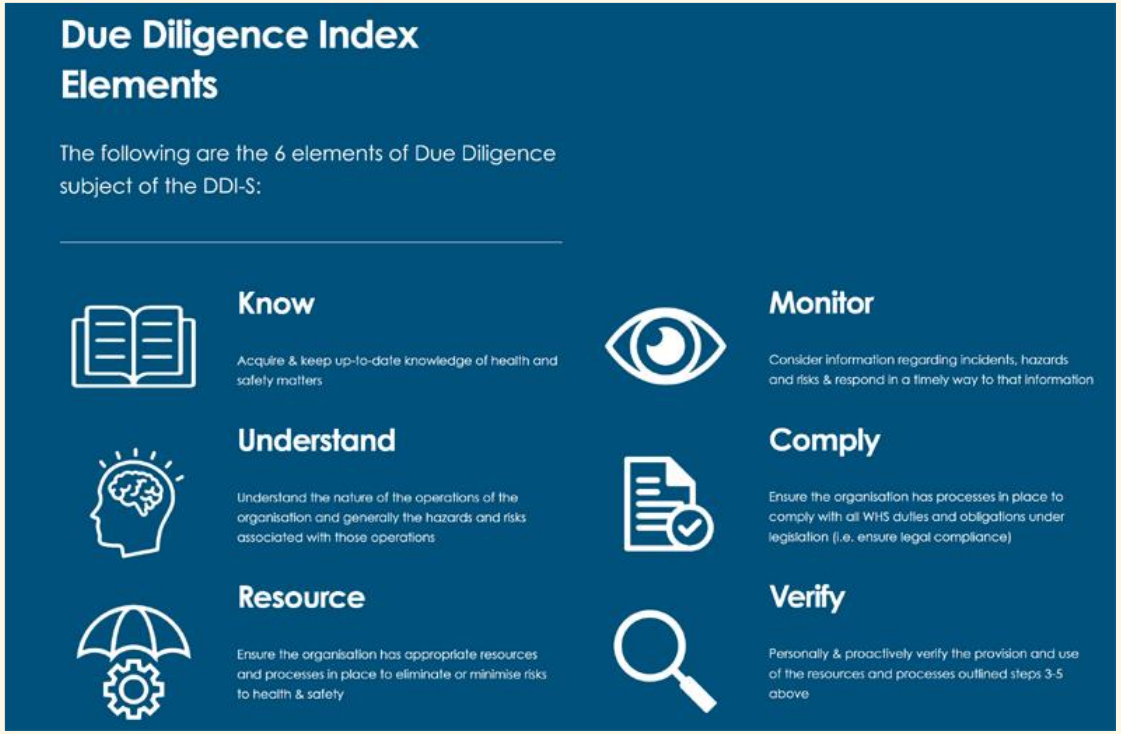
(ii) *the capacity to understand the nature of operations and their risks*, tracking anticipation through risk competence and risk appreciation at all levels of the organization (Understand);

(iii) *the capacity to resource for safety adequately*, tracking the capability to make resources available and goal conflicts visible (Resource);

(iv) *the capacity to respond to risks and unsafe events*, tracking the capability to monitor and identify issues through effective communication channels (Monitor);

(v) *the capacity to demonstrate engagement and compliance*, tracking the capability of ensuring the effectiveness of monitoring (Comply); and

(vi) *the capacity for assurance*, tracking the capability to learn from both failure and success (Verify).



Where to from here? – *the interdisciplinary challenge*

Modern indoor air science has been driven by two forces:

- the demands to fix important indoor air problems arising from a broad variety of pollutants;
- new technologies such as CFD, big data analysis, advanced chemical analytical capability, sensing, control, and human biomarker analysis.

Y. Zhang et al. (eds.), Handbook of Indoor Air Quality, 2022
https://doi.org/10.1007/978-981-10-5155-5_1-1

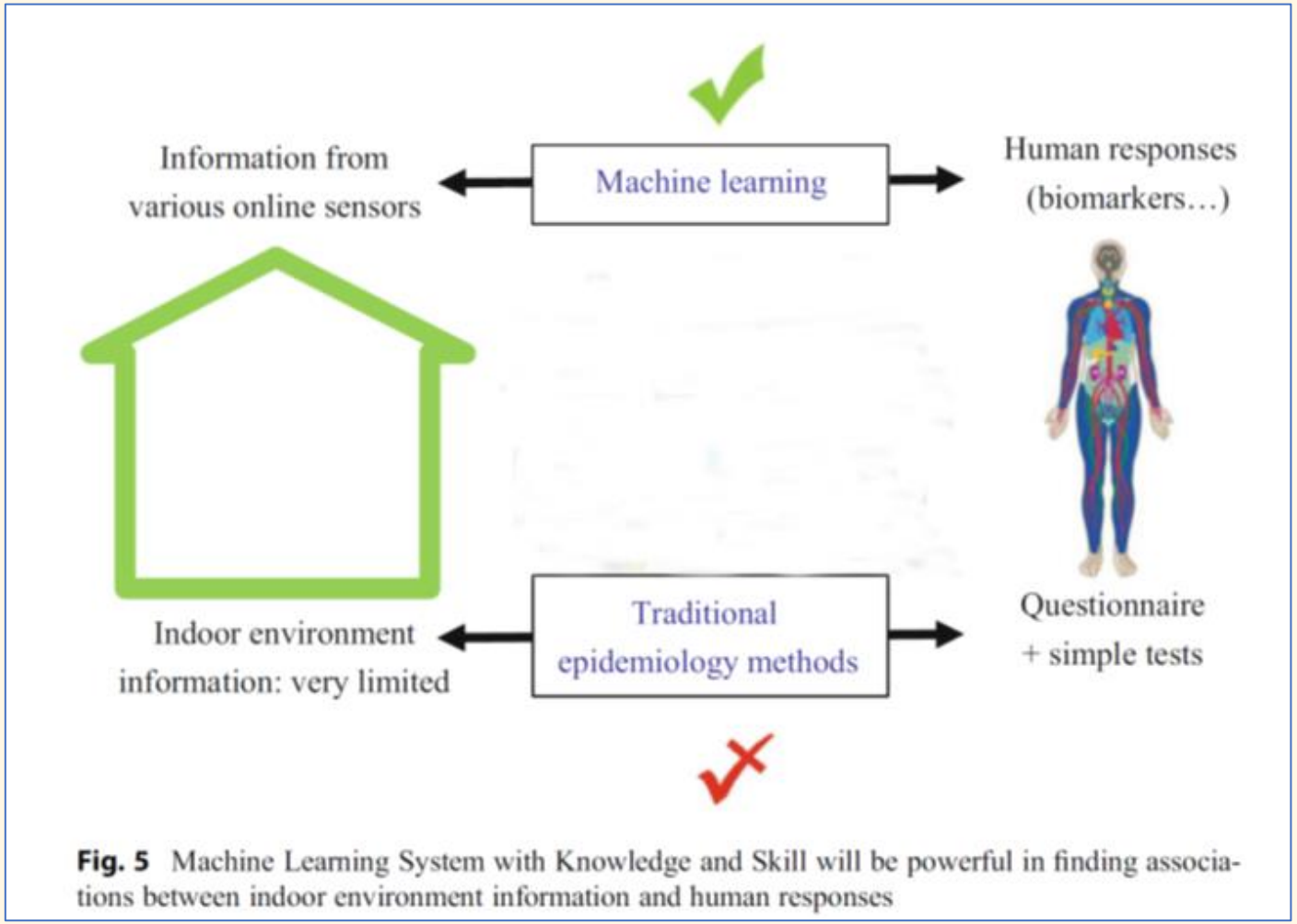


Fig. 5 Machine Learning System with Knowledge and Skill will be powerful in finding associations between indoor environment information and human responses

Y. Zhang et al. (eds.), Handbook of Indoor Air Quality, 2022
https://doi.org/10.1007/978-981-10-5155-5_1-1

International Laboratory for Air Quality and Health

ARC Training Centre for Advanced Building Systems Against Airborne Infection Transmission (2023 - 2028). Led by Lidia Morawska, QUT.

The aim of the Centre is to design and develop a building system whose elements work together to reduce indoor airborne infection transmission by improving indoor air quality (IAQ) and at the same time maintaining comfort and energy efficiency.

This will entail a multidisciplinary approach
Architects, civil and mechanical engineers, facilities managers, and building system component manufacturers, as well as health scientists and WHS professionals.

Evolution of thinking regarding ventilation as part of IAQ management

Approach	Conceptualisation	Issues
"Dilution with outdoor (fresh) air is the solution"	Traditional thinking, based on common sense and simplistic assessments.	Outdoor air pollution has been linked with excess morbidity and mortality. Submicron particles and VOCs not efficiently mitigated by traditional HVAC filters.
"Dilution with air cleaning is the solution"	More recent engineering design thinking, recognising the issues with outdoor air quality, occupant expectations and energy consumption.	Doesn't really address directionality of air movement, and some generalisations about work and workers. Limited endpoints and smart ventilation criteria.
"Air cleaning and directional ventilation is the solution"	Latest thinking, arising from COVID-19 related research and experience	More holistic approach, but only one aspect of risk management. Requires interdisciplinary and systems thinking. A "source-path-receiver" framework is relevant, along with computational fluid dynamics etc

Mechanical ventilation

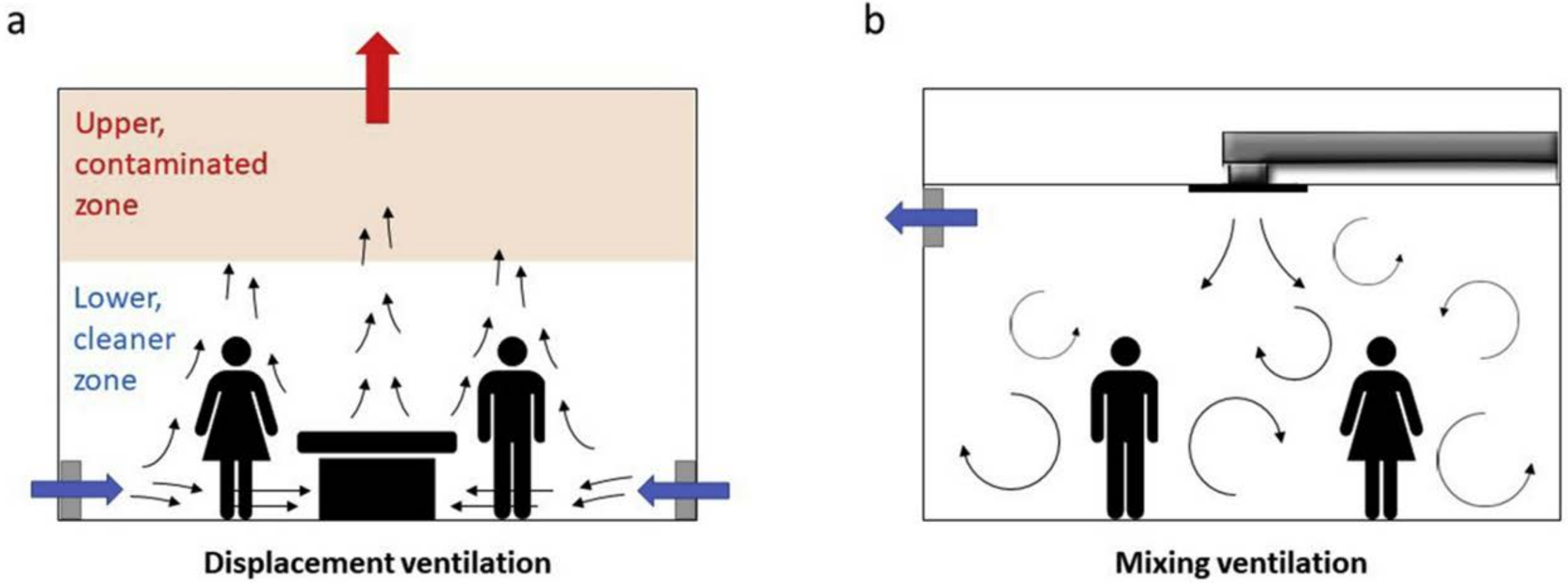


Fig. 2. Concept of (a) displacement ventilation; (b) mixing ventilation.

Displacement ventilation keeps aerosols near the infected source, before they eventually rise to the ceiling

Blocken B, van Druenen T, van Hooff T, Verstappen PA, Marchal T, Marr LC. Can indoor sports centers be allowed to re-open during the COVID-19 pandemic based on a certificate of equivalence?. *Build Environ*. 2020;180:107022.

Take home messages

- We are at a turning point where IAQ will likely assume a greater importance in line with worker and community knowledge and expectations, and new standards and systems.
- COVID-19, and the working from home option for many office workers, has forced us to rethink the role of ventilation, and the relative effectiveness of health hazard control options.
- More advanced building systems will emerge, aligned with energy efficiency and comfort.

  The widespread use of relatively cheap sensors for IAQ will allow us to monitor and diagnose IAQ issues more efficiently, removing some of the current subjectivity and delays in action.
- WHS professionals should assume coordinating and/or advisory roles, as part of normal WHS management systems.
- The nature and scope of specific regulation of IAQ is likely to evolve, which will hopefully reinforce voluntary efforts.

Thank you

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SAFE WORK MONTH 2023

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Enjoy your morning #SafeTea

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SAFE WORK MONTH 2023

old diseases, new approaches

how did we miss it and what are we doing now about the resurgence of occupational respiratory illnesses in Australia?

Tracey Bence

Fellow Australian Institute Of Occupational Hygienists (AIOH)

Certified Occupational Hygienist (COH)®

AIOH 2023 President

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Before acting on this advice, you should consider the appropriateness of the advice having regard to your own circumstances.

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Overview:

- **Historical** disease resurgence we didn't see coming
- **Recent** developments in health and hygiene
- **New approaches** from AIOH
  - media presence
  - collaboration with range of stakeholders
  - precautionary principle
- **Lessons learned**
- **Future ready**

Tracey Bence

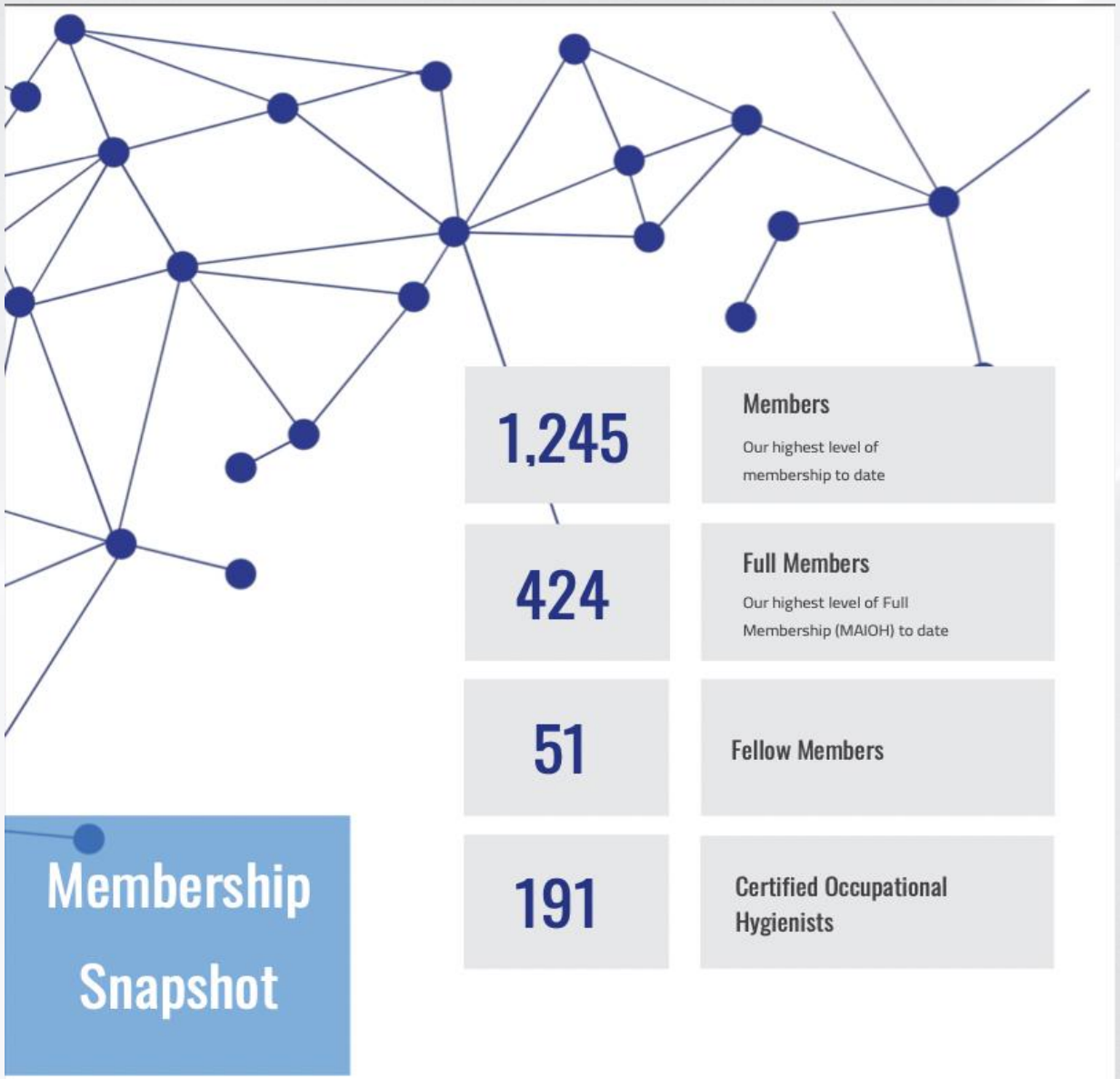
MEDIA AMBASSADOR | PRESIDENT

2023

about AIOH

AIOH membership is open to

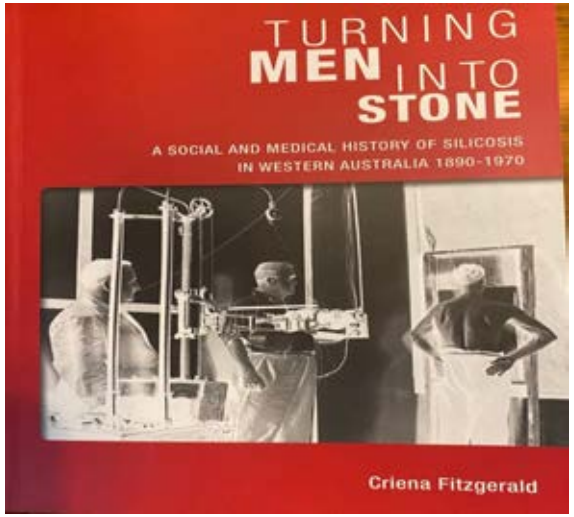
- professional occupational hygienists
- all those with an interest in
  - worker health protection and
  - a healthier work environment.

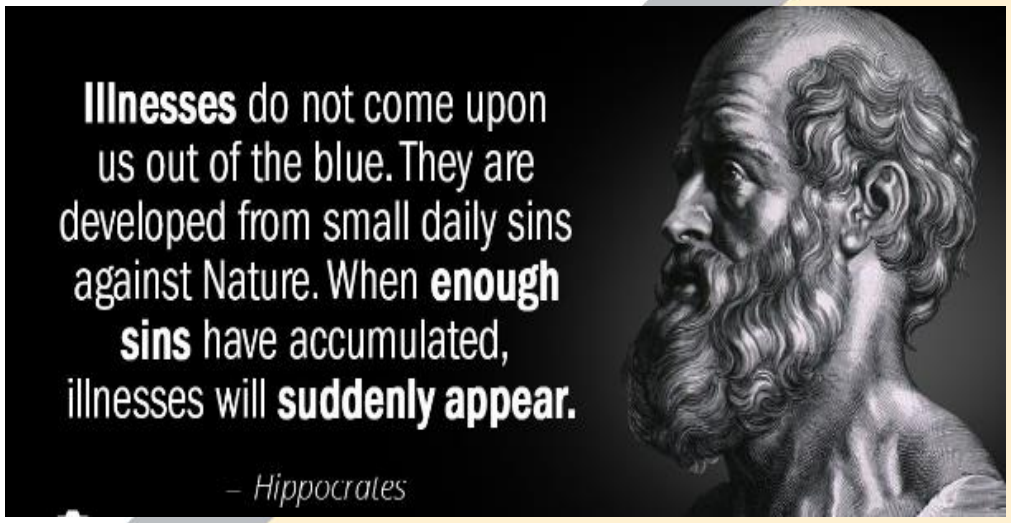


1900's: dust diseases from distant past

- Dust diseases documented by Hippocrates, Agricola and Pliny the Elder in 1st Century
- Historic studies record large scale silicosis cases in Australia in
  - tunnelling
  - stone masonry
  - sand blasting
- WA mining tuberculosis – silicosis epidemic in the 1950's.
- Earliest welfare and compensation bodies were for miners with silicosis and tuberculosis – State Government Insurance Office (SGIO) in Western Australia


A GANG OF ROCKCHOPPERS—TAKEN SEVEN YEARS AGO.
Out of this group of thirty men *sixteen* are now dead.





2000s: faint signals, mixed messages

- Coal Worker Pneumoconiosis (CWP) on the rise in 1990s in UK and US

(Scarisbrick & Quinlan, 2002 and Laney & Attfield, 2010)

- RCS causes silicosis chronic bronchitis, emphysema, small airways disease

(Hnizdo & Vallyathan, 2003).

- Occupational exposure accounts for 10-20% of symptoms of Chronic Obstructive Pulmonary Disease (COPD) in miners, tunnellers and others (Balmes et al, 2003).
- Australia to see increase in toxic dust workplace-related disease (White Inquiry, 2005)
- No prosecutions for exposing workers to dust-disease (Faunce et al, 2006).
- No disease consistent with exposure to RCS or coal dust 1990 - 2000

(NSW Coal Miners Insurance, 2002)

- AIOH opposes SWA proposal to reduce the RCS WES (AIOH, 2005)

2010s: early signs

- 2010 explosion in US mine, autopsies show 17/24 dead miners had CWP
- 16 mining states in US report CWP on the rise and in surface miners (CDC,2012)

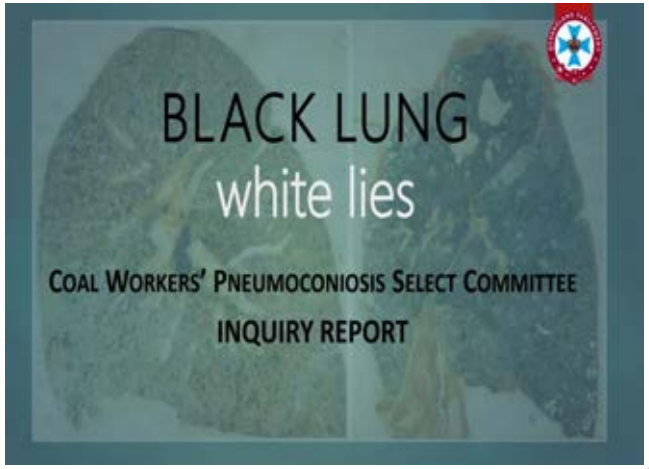
There is a problem in our control of our exposure to dust that's causing worsening disease and resurgent disease.

Upper Big Branch coal mine disaster

- For every 1000 US workers exposed to RCS 0.05 mg/m3 Time Weighted Average over 45-years
  - 19 are at risk of lung cancer
  - 54 are at risk of non-cancer lung disease other and
  - 75 are at risk of silicosis (NIOSH,2011)

2015: the awakening, ‘black lung’

- 22 coal miners in Queensland diagnosed with CWP
- Government launched ‘*Black Lung, White Lies*’ inquiry involving
  - 190 witnesses
  - 47 submissions
  - 40+ summonses
  - 10,000+ documents
- ‘the entire QLD coal industry was shocked’ when CWP emerged in their workers (CWP Select Committee Inquiry, 2016)



2016: rude awakening - not re-emergence

Key findings of *Black Lung, White Lies* Select Committee Inquiry:-

- CWP did not ‘re-emerge’ in 2015 but was simply re-identified
- No 'actual health surveillance’ for 30 years
- Chest X-rays were not offered, read correctly or read at all
- False assumption that only underground workers at risk of CWP
- WES not protective enough against CWP, Coal Mine Dust Lung Disease and other Occupational Respiratory Diseases.
- Real-time personal dust monitoring is key to dust mitigation (CWP Inquiry,2016).

2017: fall out from ‘system failures’

- re-identification of CWP is ’sobering evidence of systems failure’ and industry reproached for the ‘enormous faith’ they put in health surveillance to reveal problems with its workers

  (*Black Lung, White Lies*’ inquiry 2016)
- AIOH states ' little point in employers being required to submit exposure and health surveillance data, if it cannot be routinely interrogated, analysed and reported back to industry .....
- ABC Journalist Matthew Peacock says he considered Australian hygienists were 'asleep at the wheel‘ in light of more CWP deaths.

Matt Peacock

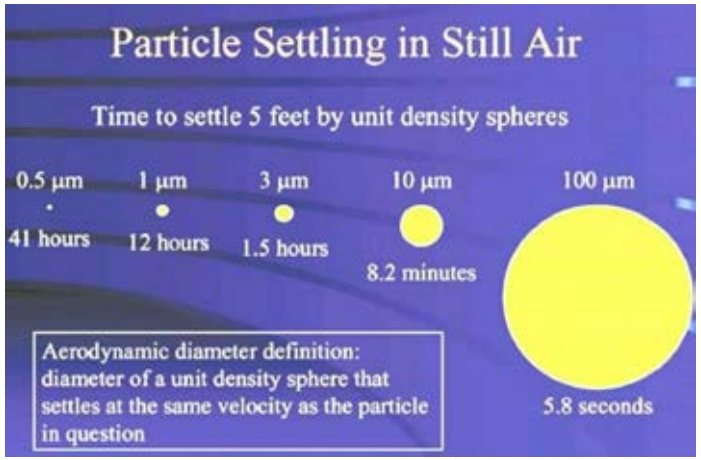
Matt Peacock is a senior ABC journalist who has worked for a wide range of TV and radio programs. He has been chief political correspondent for current affairs radio in Canberra, as well as the ABC's foreign correspondent in London (2001-2003), Washington (1990-1992) and New York (1993). For many years Matt worked for AM, The World Today, and PM, specialising in politics, environment and science. For seven years he also reported from outback Australia, specialising in rural and remote issues including Aboriginal affairs. He is author of several books, including *Asbestos: Work as a Health Hazard* (ABC Books, 1978) and *The Forgotten People - a History of Australia's South Sea Islanders* (ABC Books, 1978). More recently he has written a history of the former Australian asbestos manufacturer James Hardie, called *Killer Company* (HarperCollins, 2009), which is soon to become a dramatic mini-series on ABC TV called "Devil's Dust". Matt is Adjunct Professor of Journalism with Sydney's University of Technology (UTS).

2018:more CWP, more silicosis, more uncertainty

- From QLD health monitoring of 35 engineered stone workers
  - 12 diagnosed with Silicosis by ILO Chest X-ray, 4/5 from 1 workplace
  - 7 with Progressive Massive Fibrosis (PMF) by High Resolution CT
- SWA prioritises its review of Respirable Crystalline Silica WES
- AIOH and NATA release *RCS Measurement - Statement of Common Interests* citing an intention to protect worker health but
  - expressing concerns for sampling practices and analytical methods and
  - warning ‘the extent of variability has significant implications for attaining and demonstrating regulatory compliance’ at (current) and proposed RCS WES

the trouble with silica

Source: Dust Control Handbook for Industrial Minerals Mining and Processing, Cecala et al., 2012



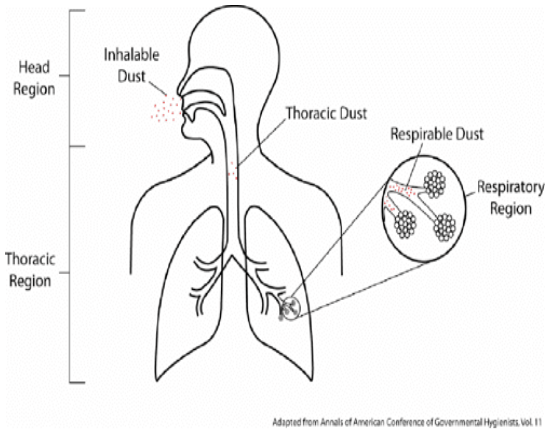


Figure 1.1: Regional Particle Deposition [9]

2019: high price of engineered stone

'He won't be the last to die': Brother of first stonemason killed by silicosis says THIRTY of his colleagues have been diagnosed with the same deadly lung disease

- The brother of a tradesman who died from silicosis has also been diagnosed
- The rare lung disease is caused by breathing in dust from kitchen benchtops
- Anthony White was diagnosed with the disease in 2017 and died on Saturday
- Brother Shane revealed he was also diagnosed only days before Anthony died
- He said 30 of his friends also contracted the disease and many more will die

- 98 /799 QLD engineered stonemasons confirmed with Silicosis.
- 15/98 had Progressive Massive Fibrosis (terminal stage).
- 23 year old diagnosed after 6 years of engineered stone exposure
- Australia's 1st artificial stone mason dies at 36 years old from PMF.
- Number of silicosis cases in QLD increases to 106

2019: RCS WES reviews

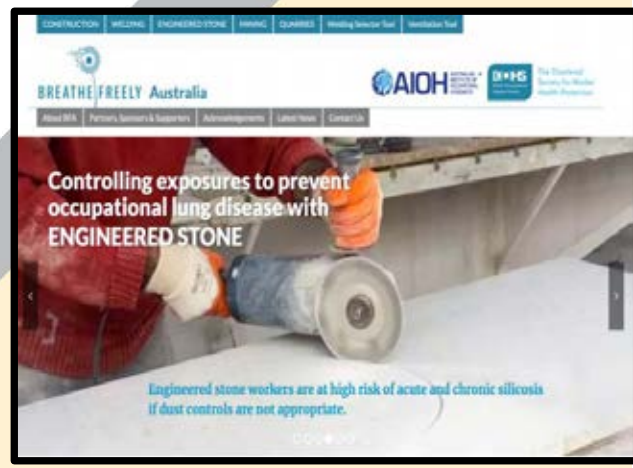
- Media and union involvement continues
- AIOH launches Breathe Freely Australia® and roadshows
- SWA concludes review into lowering the RCS WES from 0.05 mg/m3 stating
  - no clear No Observed Adverse Effect Concentration (NOAEC) in humans and
  - chronic exposures >0.02 mg/m3 associated with radiographic lung changes
- AIOH again opposes SWA proposal to reduce RCS WES
- American Conference of Governmental Industrial Hygienists (ACIGH) reduces RCS Threshold Limit Value (TLV®) to 0.025 mg/m3 TWA

2020: two steps forward, one step backwards

- SWA halves the RCS WES to 0.05 mg/m3 as TWA 8-hour concentration
- Analysis of RCS at 0.02 mg/m3 would significantly increase uncertainty

(Glossop & White, 2020)

- SWA launches Clean air, Clear lungs campaign
- 20/66 recommendations from *Black Lung, White Lies* Inquiry been implemented.
- Compensable Australian silicosis cases reach 412; 10-fold increase in 10 years
  (SWA, 2022)



2021: response to silicosis

- WA first to introduce lower dose high resolution CT scan for silica medicals
- SWA releases RCS *Consultation Regulation Impact Statement* (CRIS) which proposes 7 options to respond to silicosis risk.
- Vic. introduces regulations to apply at >40% silica content in engineered stone
- Hygienists begin telling the story of the scale of exposures

Fears For Silicosis, The Deadly Dust Disease, In Workers In More Industries – The Project Channel 10

2022: bleak future predicted

- Modelling predicts > 10,000 lung cancers and ~ 100,000 silicosis cases from current levels of Australian exposures to silica dust at work (Carey, 2022)
  - Highest risk in engineered stone, construction, mining and quarrying
  - These estimates exclude tunnelling
- Unionists, lawyers, public health organisations, occupational physicians and hygienists unite in Canberra to warn Government of scale of the RCS problem

Kate Cole
President
Australian Institute of Occupational Hygienists

Mark Brooke
Chief Executive Officer
Lung Foundation Australia

Liam O'Brien
Assistant Secretary
Australian Council of Trade Unions (ACTU)

Tim Driscoll
Chair, Occupational and Environmental Committee
Cancer Council Australia

Dominic Yong
President
The Australian and New Zealand Society of Occupational Medicine Inc (ANZSOM)

2023: Engineered stone ban decision pending...

SWA consider 3 options for the ban. Prohibit use of

1. All engineered stone products OR
2. Engineered stone containing 40% or more crystalline silica OR
3. Option 2 plus a licensing scheme for <40% crystalline silica engineered stone

AIOH favour a precautionary approach based on unique exposure scenarios, complex material science and the difficulty of regulating current and new products.

Safe Work Australia is examining a silica ban following a meeting of responsible ministers.-AAP Image

Australia's construction union is ramping up calls for a nationwide ban on engineered stone benchtops to protect workers from deadly diseases.

Webinar – Update on Engineered Stone and the Complexity of its Health Effects

Media: a platform for worker health messages

Radio Interview – President Tracey Bence & Warren Moore – 2GB Sydney

[Breathe Freely Mandarin video]

Tracey Bence
MEDIA AMBASSADOR | PRESIDENT 2023

Kate Cole OAM
MEDIA AMBASSADOR - SILICA | IMMEDIATE PAST PRESIDENT

Julia Norris
MEDIA AMBASSADOR - COVID-19 | PAST AIOH PRESIDENT

AWU member and silicosis victim Joanna joined Occupational Hygienist Kate Cole OAM – Channel 7 News

AUSTRALIAN INSTITUTE OF OCCUPATIONAL HYGIENISTS

aioh.org.au

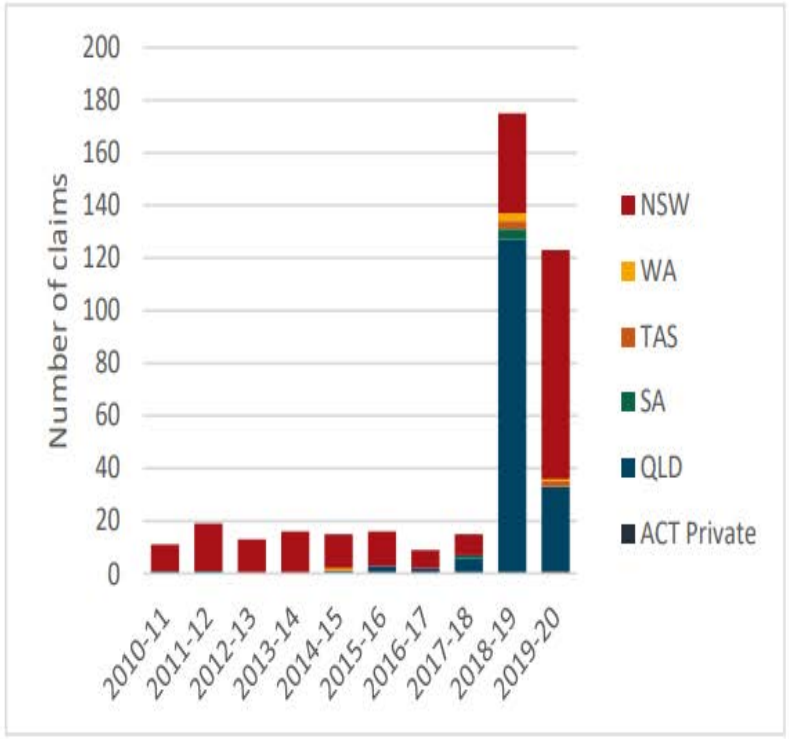
Re-learning the lessons from history and applying the hygienists core skills


ANTICIPATION
RECOGNITION
EVALUATION
CONTROL
INDUSTRIAL
HYGIENE

Lesson #1 Anticipation:

Absence of evidence ≠ evidence of absence

Between 2010-11 and 2019-20 there were 412 accepted workers' compensation claims for silicosis in the jurisdictions covered by the model WHS laws (Figure 1). Approximately 77 per cent (around three quarters) of the accepted claims were in the manufacturing, mining and constructions sectors (Table 6).

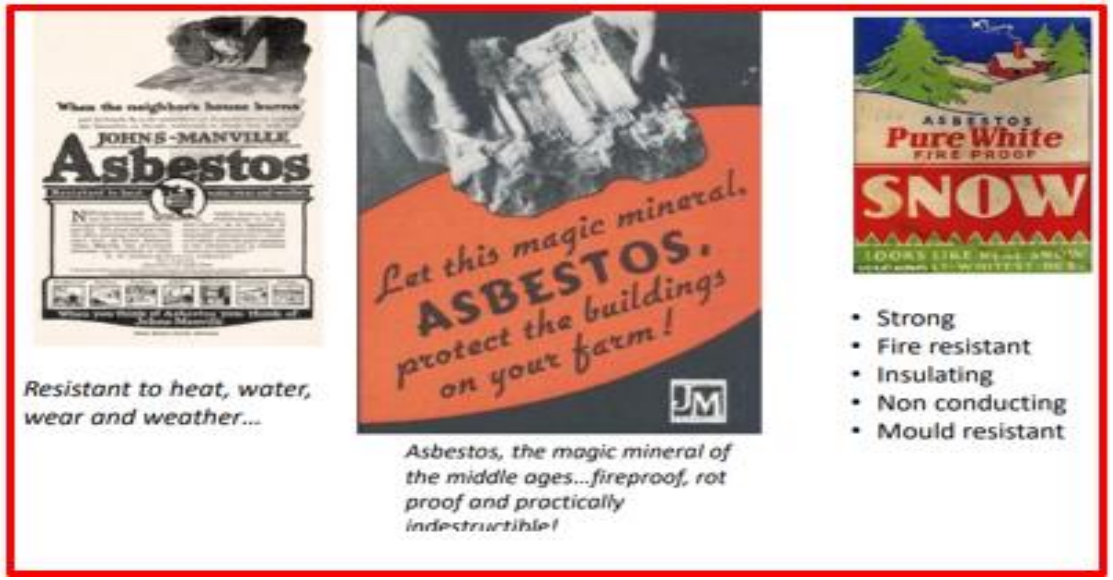


Sources: Safe Work Australia's National Data Set for Compensation-based Statistics and icare.

Figure 1: Total number of accepted silicosis workers' compensation claims in jurisdictions subject to the model WHS laws, 2010-11 to 2019-20

Lesson #2 Recognition:

History can repeat itself, unless we change it



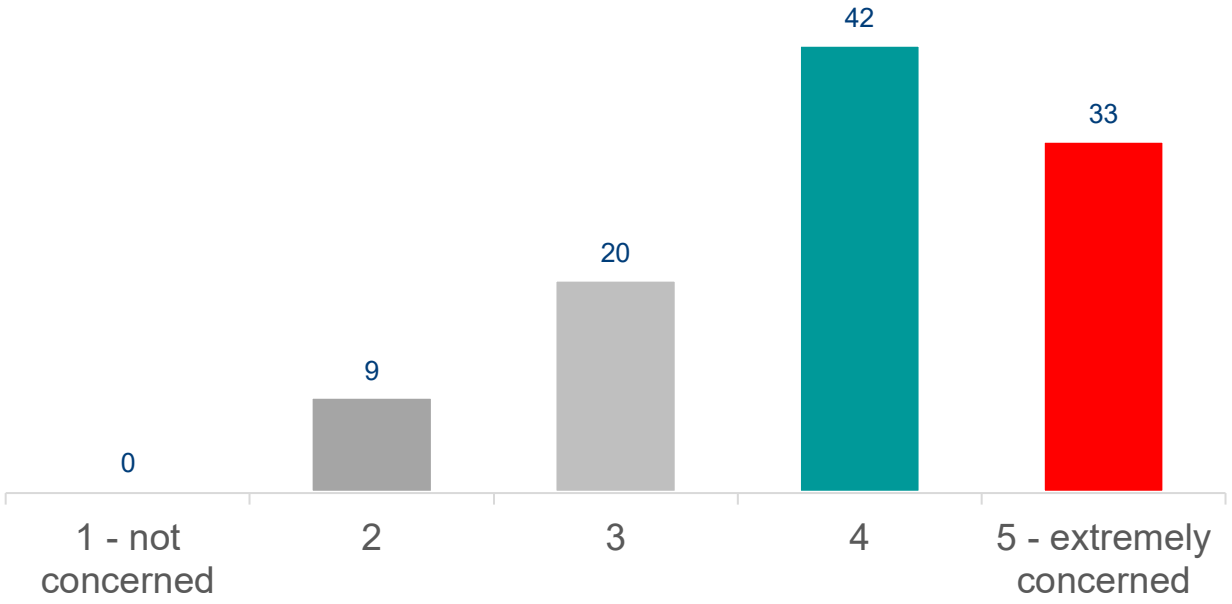
Lesson #3 Evaluation:

You don’t always need to measure it to know it’s not OK

Lesson #4
Control:

Never stop
at Lesson #3

Lesson #5 Ethics:
If it doesn't feel right, it probably isn't …



Annals of Work Exposures and Health, 2023, Vol. 67, No. 2, 281–287
https://doi.org/10.1093/annweh/wxac064
Advance Access publication 16 September 2022
Short Communication

BOHS British Occupational Hygiene Society — The Chartered Society for Worker Health Protection — OXFORD

Short Communication

Prevention of the Occupational Silicosis Epidemic in Australia: What Do Those Who Assess Workplace Health Risk Think Should Be Done Now?

Kate Cole[1,2], Deborah Glass[1,3], Tracey Bence[1,4], Dino Pisaniello[1,5,*], Peter Knott[1,6], Shelley Rowett[1,7] and Sharann Johnson[1,8]

Figure: Survey of hygienists level of concern regarding over-exposure to RCS

(Annals of Workplace Exposures and Health, 2022)

looking to the future – new WES

AIOH Launch of 12 ‘explainer’ videos to demystify WES and occupational hygiene practices on YouTube

What is a Workplace Exposure Standard?
How does time weighting work?
What are the Notations?
How do we measure airborne contaminants?
What is meant by routes of entry?
What are chronic and acute health effects?
Does particle size matter?
How do we measure RCS, Asbestos,
Sulphur Dioxide and Diesel Particulate Matter?
Top 5 Tips of exposure assessment!

getting ‘future ready’ at AIOH Conference

Exhibition with Scientific and Social programs

- typically attracts 500 + delegates
- Always on in the first week of December
- 2023 in Melbourne
- 2024 in Perth
- 2025 in Adelaide

AIOH23
ANNUAL SCIENTIFIC CONFERENCE & EXHIBITION

FUTURE READY:
transformative,innovative,relevant

THANK YOU WORKSAFE WA .





AUSTRALIAN INSTITUTE OF OCCUPATIONAL HYGIENISTS ® 40 YEARS

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ABN : 50 423 289 752
OFFICE : Suite 11, 99 - 101 Western Avenue, Westmeadows VIC 3049
POSTAL : PO Box 2124 Gladstone Park Vic 3043

PHONE : (03) 9338 1635
EMAIL : ADMIN@AIOH.ORG.AU
WEB : WWW.AIOH.ORG.AU

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GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Diesel engine exhaust

Dr Matthew Govorko

KNOW Workplace Cancer Coordinator, Cancer Council WA

Cancer Council

KNOW WORKPLACE CANCER

Occupational cancer in Australia

Sooting the record straight on diesel engine exhaust and cancer

Occupational cancer in Australia

Pick your engines carefuelly:

Diesel engine exhaust exposure and cancer

Occupational cancer in Australia

- Occupational cancers are those that occur due to exposure to carcinogenic agents in the workplace.
- Workers can be exposed to these agents **more frequently**, at **higher concentrations** and for **longer periods of time.**
- Approximately **3.6 million** Australians are exposed to at least one carcinogen in the workplace each year.
- Estimated to cause over **5,000 new cases of cancer** in Australia each year.
- **PREVENTABLE!**

To reduce the incidence of cancers attributed to occupational and environmental carcinogens in the Australian working population.

Policy & Advocacy	Advocating for and promoting awareness of evidence-based policy reform.
Resource Development	Developing relevant resources that provide information on key workplace cancer risks, effective control measures, and legal obligations.
Promotion	Promoting policy-focused messages and resources via social, print, and online media platforms.

Diesel engines

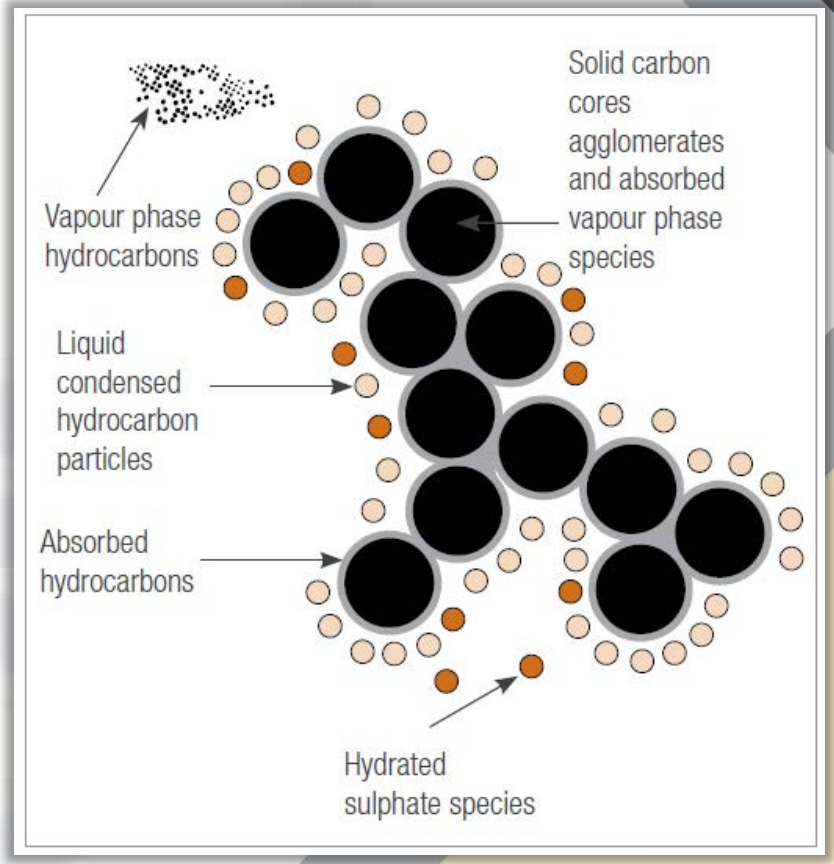
- Diesel engines are compression-ignition internal combustion engines that use high compression to ignite diesel fuel.
- Widely used for on-road and non-road applications in various industries.



What is diesel engine exhaust (DEE)?

A complex mixture of gases and particulate matter

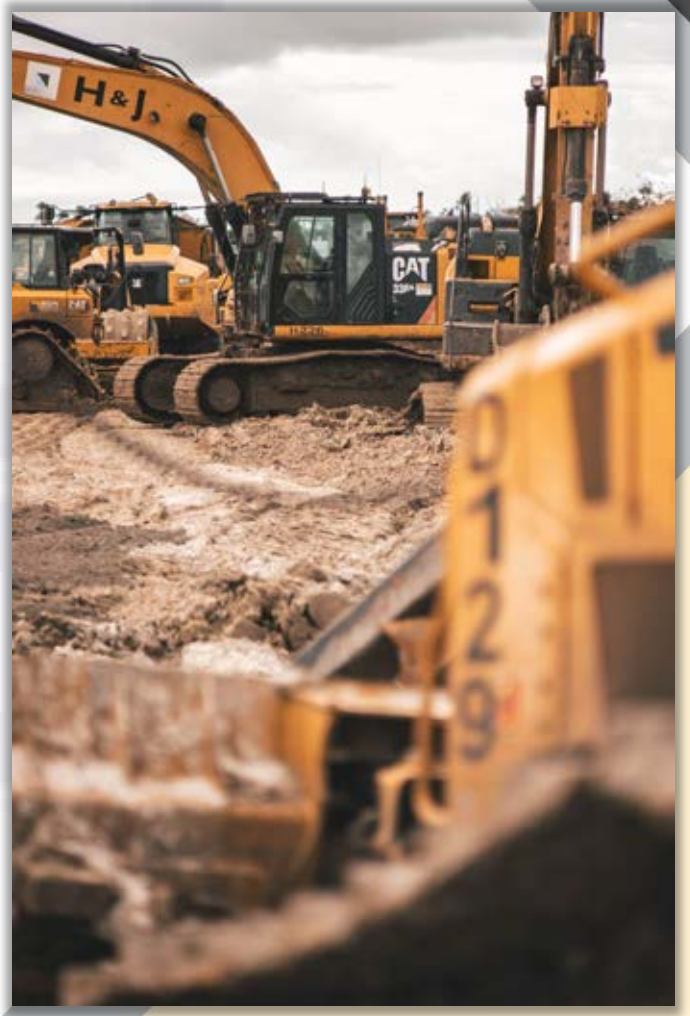
- Gaseous components: nitrogen, oxygen, carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and hydrocarbons
- Particulate matter: tiny, inhalable particles consisting of soot, ash, and organic compounds
- Carcinogens can include benzene, formaldehyde, and polycyclic aromatic hydrocarbons (PAHs)



Source: Department of Mines and Petroleum (2013)

How workers can be exposed

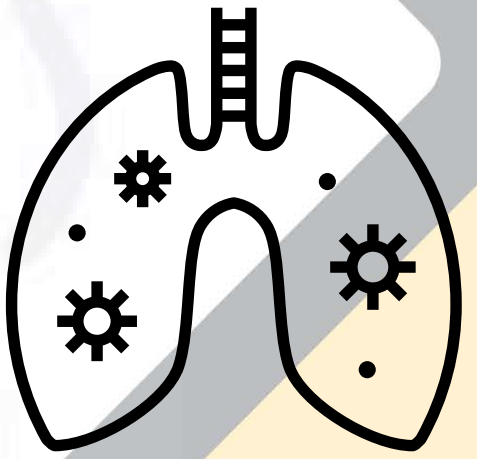
- **Any** worker can be exposed if they work with or around diesel-powered engines, especially in **confined spaces** or work areas with **poor ventilation.**
- **Occupational settings:** Mining, transportation, construction, agriculture, manufacturing, warehouse and distribution centres, tunnelling and underground operations, maritime operations.
- **Activities and tasks:** Engine operation, maintenance and repairs, loading/unloading.



Health effects of DEE

Short-term (acute) effects

- Coughing, wheezing, and sore throat
- Headaches, dizziness, and nausea
- Aggravation of pre-existing respiratory conditions



Long-term (chronic) effects

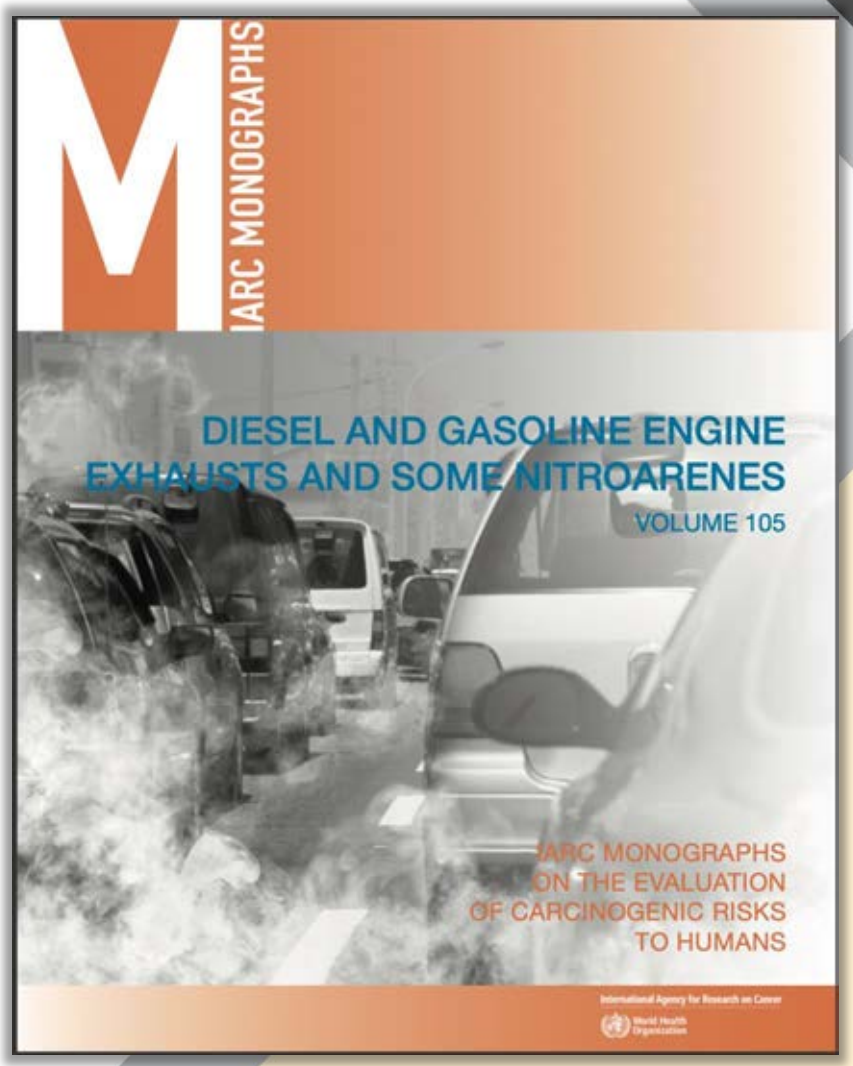
- ↑ risk of lung cancer
- ↑ risk of heart and lung disease

International Agency for Research on Cancer (IARC)

- In 1989, IARC classified DEE as *probably carcinogenic to humans* (Group 2A)
- In 2012, IARC classified DEE as *carcinogenic to humans* (Group 1)

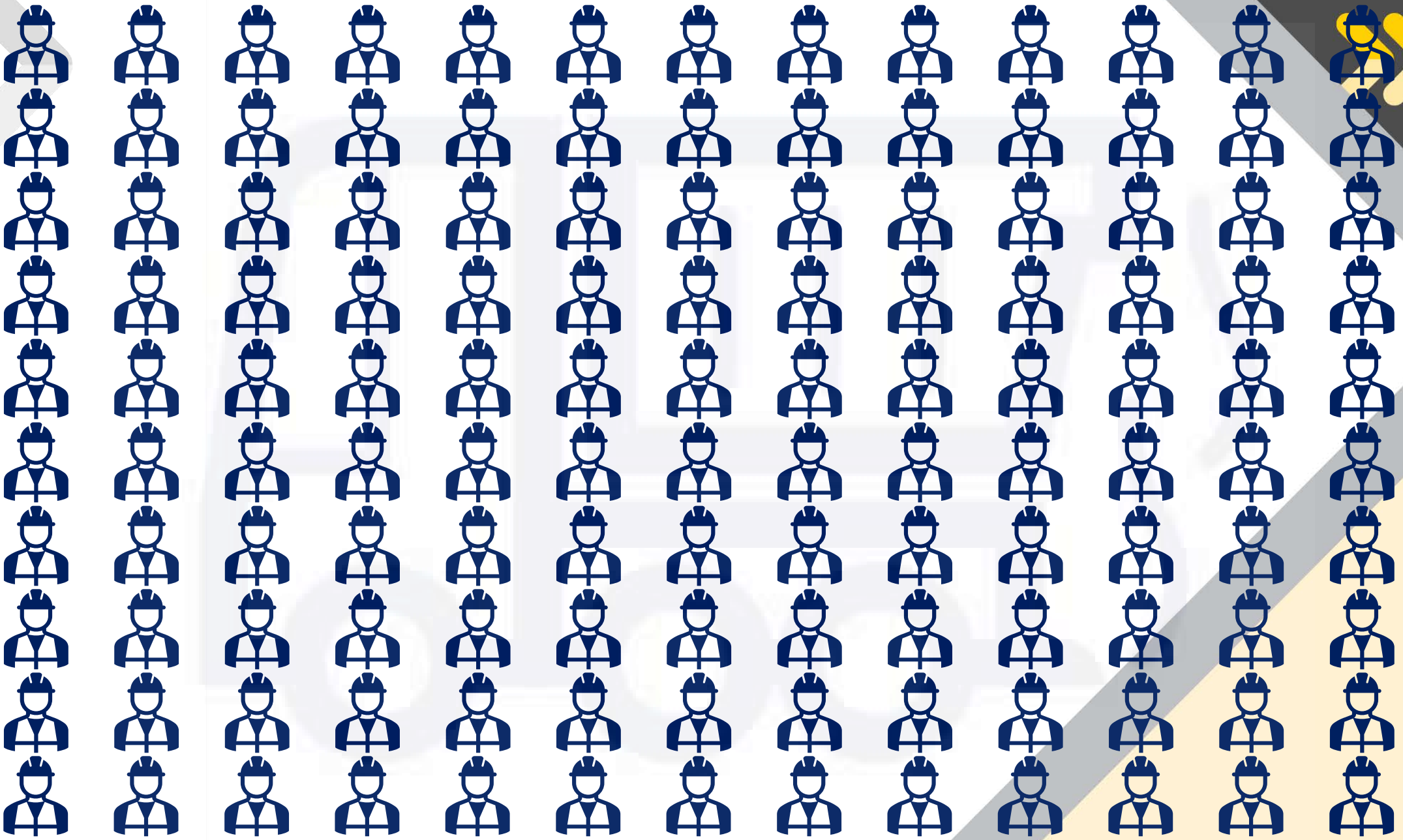
6.1 Cancer in humans

There is *sufficient evidence* in humans for the carcinogenicity of diesel engine exhaust. Diesel engine exhaust causes cancer of the lung. A positive association has been observed between exposure to diesel engine exhaust and cancer of the urinary bladder.



Cancer risk

- Cancer risk from DEE depends on the amount of exposure.
- Risk increases with **long term** or **repeated, high-level** exposure.
- Risk affected by **many** factors:
  - Location
  - Ventilation
  - Number of engines,
  - Type, age, size, state, and temperature of engine
  - Pattern of use
  - Length of time worker is exposed



Ann. Occup. Hyg., 2015, 1–9
doi:10.1093/annhyg/mev006

BOHS
The Chartered Society for Worker Health Protection

The Australian Work Exposures Study: Prevalence of Occupational Exposure to Diesel Engine Exhaust

Susan Peters[1*], Renee N. Carey[2], Timothy R. Driscoll[3], Deborah C. Glass[4], Geza Benke[4], Alison Reid[2] and Lin Fritschi[2]

Prevalence of exposure

- 18.5% of respondents were exposed to DEE in their current job.
- 13.4% of respondents were **substantially** exposed to DEE in their current job.
- Gender: 20.4% males vs. 4.7% females
- State: 6.4% ACT to 17% WA
- Remoteness: 10.4% in major cities to 28.1% in remote areas

Workers at risk

Occupational groups with the highest proportion of workers substantially exposed:

- Agriculture (75.2%)
- Mining (67.9%)
- Transport (56.9%)
- Mechanics (49.6%)
- Construction (15.2%)

Table 2. Occupations with the highest proportions of substantially exposed to diesel exhaust.

Industry/occupational group	*N*	Substantially exposed *N* (%)	Medium exposed *N* (%)	Highly exposed *N* (%)
Overall	4993	670 (13.4)	583 (11.7)	87 (1.7)
Agriculture	222	167 (75.2)	167 (75.2)	—
Farmer/gardener	210	145 (69.0)	145 (69.0)	—
Forestry	10	4 (40.0)	4 (40.0)	—
Fisherman	2	1 (50.0)	1 (50.0)	—
Construction	184	29 (15.2)	27 (14.7)	2 (1.1)
Supervisor/foreman	20	12 (60.0)	12 (60.0)	—
Concreter	15	5 (33.3)	4 (26.7)	1 (6.7)
Other construction worker	149	12 (8.1)	11 (7.4)	1 (0.7)
Mechanics	131	65 (49.6)	23 (17.6)	42 (32.1)
Motor vehicle mechanic	59	48 (81.4)	13 (22.0)	35 (59.3)
Machinery fitter/machine assembler	72	17 (23.6)	10 (13.9)	7 (9.7)
Mining	28	19 (67.9)	15 (53.6)	4 (14.3)
Supervisor/foreman	8	5 (62.5)	4 (50.0)	1 (12.5)
Miner/quarryman	16	11 (68.8)	9 (56.3)	2 (12.5)
Mineral and stone treater	3	3 (100)	2 (66.7)	1 (33.3)
Well driller and borer	1	0 (0)	—	—
Transport/material handling	211	120 (56.9)	104 (49.3)	16 (7.6)
Docker/freight handler	13	3 (23.1)	3 (23.1)	—
Heavy equipment operator	62	27 (43.5)	17 (27.4)	10 (16.1)
Railway worker	9	5 (55.5)	5 (55.6)	—
Motor vehicle driver	127	85 (66.9)	79 (62.2)	6 (4.7)
Automobile	14	11 (78.6)	11 (78.6)	—
Bus	20	11 (53.0)	11 (53.0)	—
Truck	93	63 (67.7)	57 (61.3)	6 (6.5)

Extrapolation to the Australian working population

Table 3. Proportion of the Australian working population (18–65 years of age and employed in 2011) estimated to be substantially exposed to diesel exhaust in the workplace.

	N (×1000)	95% CI	Proportion (95% CI)
Total working population			
Total	8954		
Substantially exposed	1237	895–1829	13.8% (10.0–20.4)
Highly exposed	160	92–629	1.8% (1.0–7.0)
Males			
Total	4699		
Substantially exposed	1022	763–1383	21.7% (16.2–29.4)
Highly exposed	155	91–419	3.3% (1.9–8.9)
Females			
Total	4256		
Substantially exposed	216	132–446	5.1% (3.1–10.5)
Highly exposed	5	1–210	0.1% (0.0–4.9)

Extrapolation to the Australian working population

1.2 MILLION AUSTRALIANS

1,000,000 males

200,000 females

Contents lists available at ScienceDirect

Cancer Epidemiology

The International Journal of Cancer Epidemiology, Detection, and Prevention

journal homepage: www.cancerepidemiology.net

The future excess fraction of occupational cancer among those exposed to carcinogens at work in Australia in 2012

Renee N. Carey[a], Sally J. Hutchings[b], Lesley Rushton[b], Timothy R. Driscoll[c], Alison Reid[a], Deborah C. Glass[d], Ellie Darcey[a], Si Si[a], Susan Peters[e], Geza Benke[d], Lin Fritschi[a,*]

Future DEE-related cancers

Table 2
Cancer registrations attributable to occupational exposure in cohort of working age Australians in 2012, by carcinogen and cancer site (including only carcinogens and sites with at least 50 attributable cases).

Carcinogen	Cancer site (ICD–10 code/s)[a]																	Total attributable registrations
	Lung (C33-C34)	Leukaemia (C91-C95)														Nasopharynx (C11)	Liver (C22)	
Asbestos	3500	–	7500	–	–	–	<100	–	1000	–	–	1000	<100	–	–	–	–	13,500
Solar UVR	–	–	–	–	5500	3500	–	–	–	–	1000	–	–	–	–	–	–	10,000
Benzene	–	8000	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8000
ETS	3000						2500						500					6500
DEE	4500	–	–	–	–	–	–	1000	–	–	–	–	–	–	–	–	–	5500
Silica	5500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5500
PAHs	3000	–	–	–	–	–	–	1000	–	–	–	–	–	–	–	–	–	4500
Shiftwork	–	–	–	4500	–	–	–	–	–	–	–	–	–	–	–	–	–	4500
Nickel	3000	–	–	–	–	–	–	–	–	500	–	–	–	–	–	–	–	3500
Arsenic	2000	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2000
Chromium VI	1500	–	–	–	–	–	–	–	–	500	–	–	–	–	–	–	–	1500
Ethylene oxide	–	–	–	1500	–	–	–	–	–	–	–	–	–	–	<100	–	–	1500
Lead	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1000
Ionising radiation	<100	<100	–	500	–	–	–	–	–	–	–	–	–	–	–	–	<100	500
Wood dust	–	–	–	–	–	–	–	–	–	500	–	–	–	–	–	<500	–	500
Cadmium	<500	–	–	–	–	–	–	–	–	–	–	–	–	<500	–	–	–	500
Trichloroethylene	–	–	–	–	–	–	–	–	–	–	–	–	–	<100	<100	–	<100	<500
1,3-Butadiene	–	<500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	<500
Formaldehyde	–	<100	–	–	–	–	–	–	–	<100	–	–	–	–	–	<100	–	<100
Total	26,000	8000	7500	6000	5500	3500	3000	2500	2000	1500	1000	1000	500	500	<500	<500	<100	

DEE: Diesel Engine Exhaust; ETS: Environmental Tobacco Smoke; NHL: Non-Hodgkin lymphoma; PAHs: Polycyclic Aromatic Hydrocarbons other than vehicle exhausts; UVR: Ultraviolet Radiation.
[a] All numbers rounded to the nearest 500 to avoid a false sense of precision. Numbers may not add up due to rounding.

5500 DEE-related cancers

=

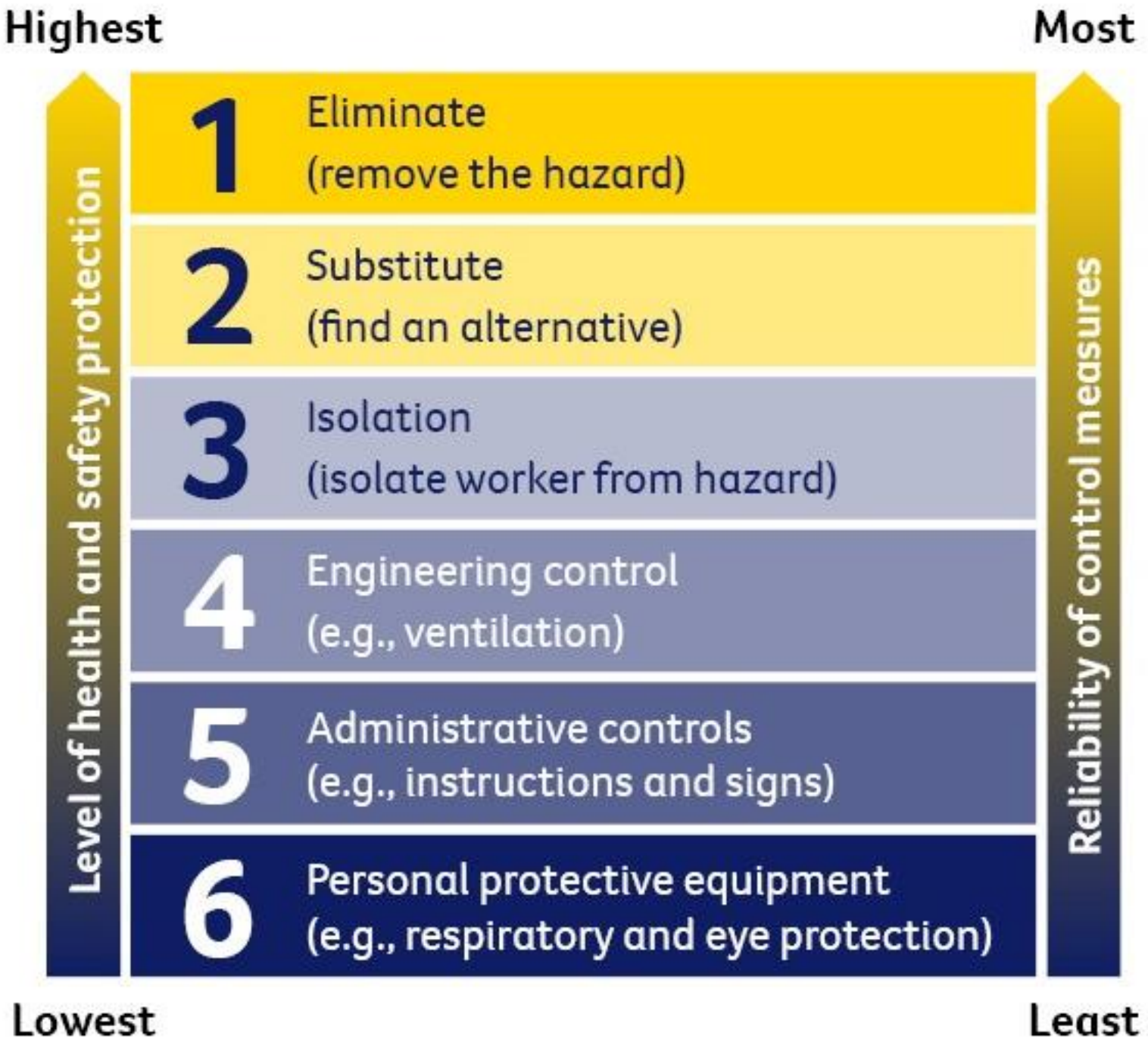
4500 Lung cancers

+

1000 Bladder cancers

What control measures are available to protect workers and reduce cancer risk?

Hierarchy of control



Elimination and substitution

- **Engine selection**
  - Replace diesel powered engines with other energy sources (i.e., electric) or choose new low emission diesel engines.
  - Use purchasing guidelines for supply of engines that meet US Tier 4 or Euro 6 standards.
- **Fuel selection**
  - Use ultra-low sulphur and other low-emission diesel fuels, fuel additives and low sulphur lubricants where possible.
  - Avoid contaminating diesel fuel and lubricating oils.

Isolation

- **Enclosed equipment**
  - Design and maintain sealed, air-conditioned cabins where possible – positive pressure, high-efficiency particulate air (HEPA) filtered air supply, leak tested.

Engineering controls

- **Engine refurbishment and emission control devices**
  - Install devices that reduce emissions – e.g., diesel particulate filters, catalytic converters, scrubbers, acoustic agglomeration, cyclones.
- **Ventilation**
  - Use both local exhaust and forced dilution ventilation.
  - Use connecting extraction pipes for vehicle exhausts in workshops.
  - Cold engine starts should occur in spaces with good ventilation.

Engineering controls – ventilation

Figure 1 Fixed length flexible hose with tailpipe exhaust extraction system

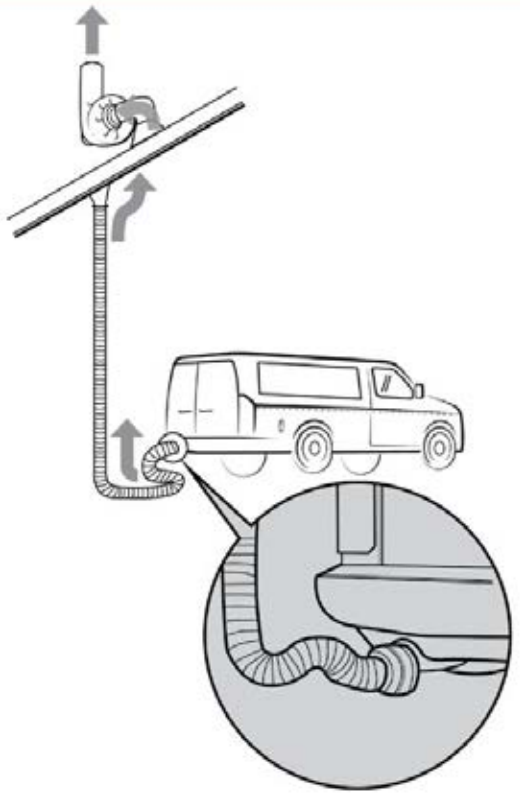
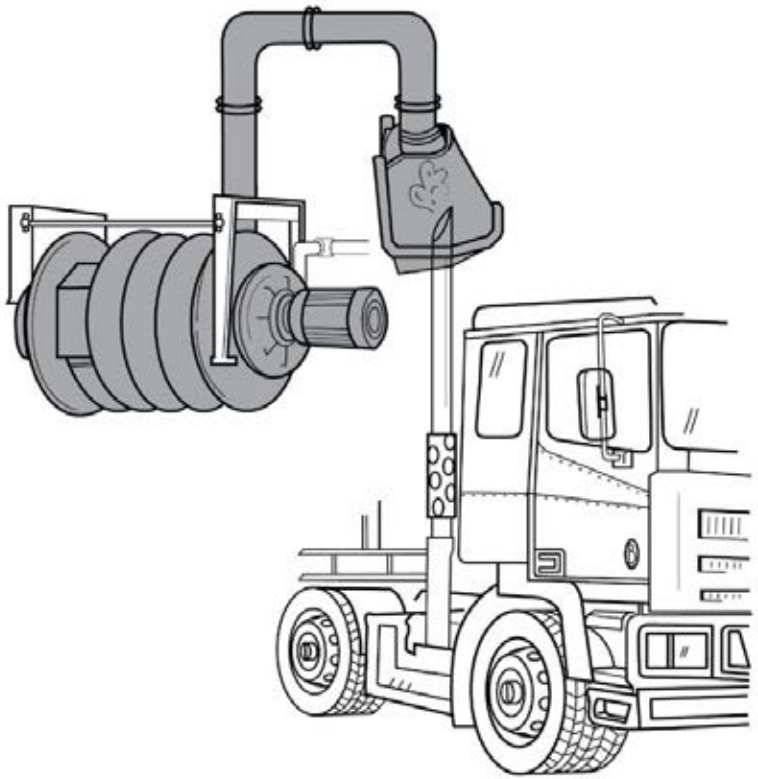


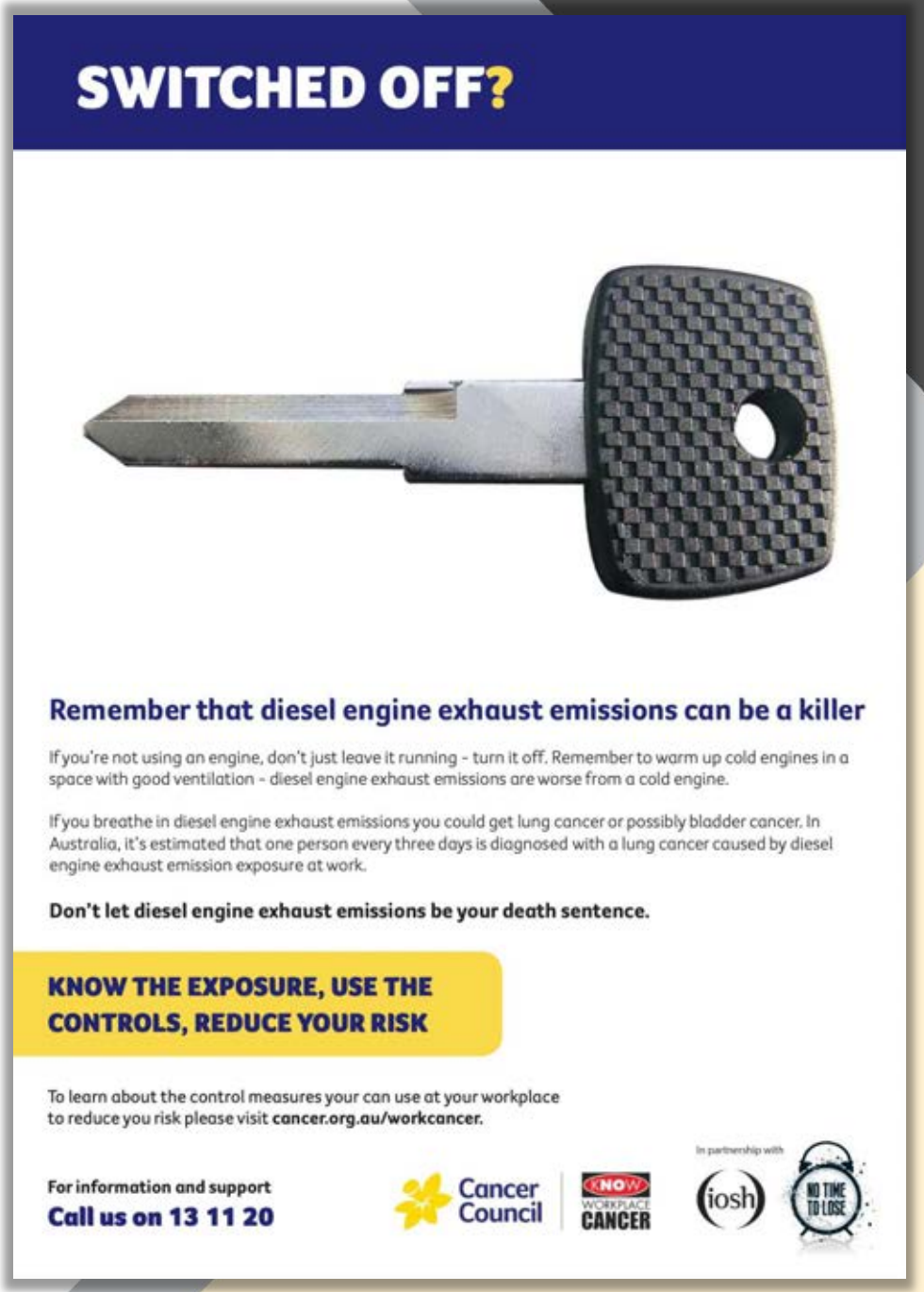
Figure 2 Fixed hose and funnel-type local exhaust extraction system



Source: Safe Work Australia (2015). *Guide to managing risks of exposure to diesel exhaust in the workplace.* https://www.safeworkaustralia.gov.au/doc/guidance-managing-risks-diesel-exhaust

Administrative controls

- **Maintenance and repairs**
  - Have a maintenance schedule for all engines and emission control equipment
  - Carry out emissions-based maintenance on engines
- **Testing of exhaust components**
  - Use raw exhaust tests
  - Test in normal working conditions
- **Engine operation**
  - Operate engines to optimize combustion
  - Limiting idling and over-revving
  - Switching off engines whenever possible



Administrative controls

- **Worker education and training**
  - On DEE health hazards and proper use of control measures
  - Should enable workers to recognise and report any deterioration in controls, changes in engine emissions, or changes in the workplace
- **Work scheduling and task rotation**
  - Job rotation between workers
  - Schedule work to minimise the number of workers near the plant whilst it is operating
  - Limitation on the number of vehicles operating in an area

Personal protective equipment (PPE)

- Last option for controlling exposure
- May or may not be appropriate depending on the situation
- Wear air supplied or air purifying respiratory protection that filters particulates
- Trained and fit-tested
- Properly stored, inspected, cleaned, and maintained

Air monitoring

- Can be used to check if exposure to diesel particulate matter (DPM) is being effectively reduced by the controls you are using.
- Currently, a workplace exposure standard (WES) for DPM of 100 µg/m^3 (0.1 mg/m^3), measured as sub-micron elemental carbon, applies to all Western Australian mining operations.
- This standard is **not** a health-based standard.
- **We recommend a health-based WES of 10 µg/m^3 (0.01 mg/m^3)** to adequately protect workers in critical industries from an elevated risk of developing lung cancer.

Awareness campaign – Safe Work Month 2023

Aim:

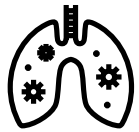
To increase awareness of the health risks associated with DEE exposure in Australian workplaces and the importance of using appropriate control measures.

Key components:

- Animated explainer video
- Paid and organic social media
- Webinar: Professor Tim Driscoll, Monday 16 October at 2:00pm AEDT / 11:00am AWST
- Campaign landing page: cancer.org.au/diesel

Supported with funding from the AIOH Foundation.

Conclusion



Diesel engine exhaust is a known cause of lung cancer.

Those working in close proximity to operating diesel equipment are potentially exposed.

Operating diesel equipment in confined areas and a lack of workplace ventilation can significantly increase the level of exposure.

Reduce your risk of cancer by lowering exposure, using good work health and safety processes.

THANK YOU!

cancer.org.au/go/workcancer

matthew.govorko@cancerwa.asn.au

GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Regulating radiation exposures from naturally occurring radionuclides (NORs)

Dr Martin Ralph CRadPro

Regional Inspector of Mines, WorkSafe Mines Safety

Today’s presentation

- Radiation and radioactivity: some principles
- Radiation exposure and risk
- NORs in the WA mining industry
- The WA regulatory framework
- A peek over the horizon – emerging challenges

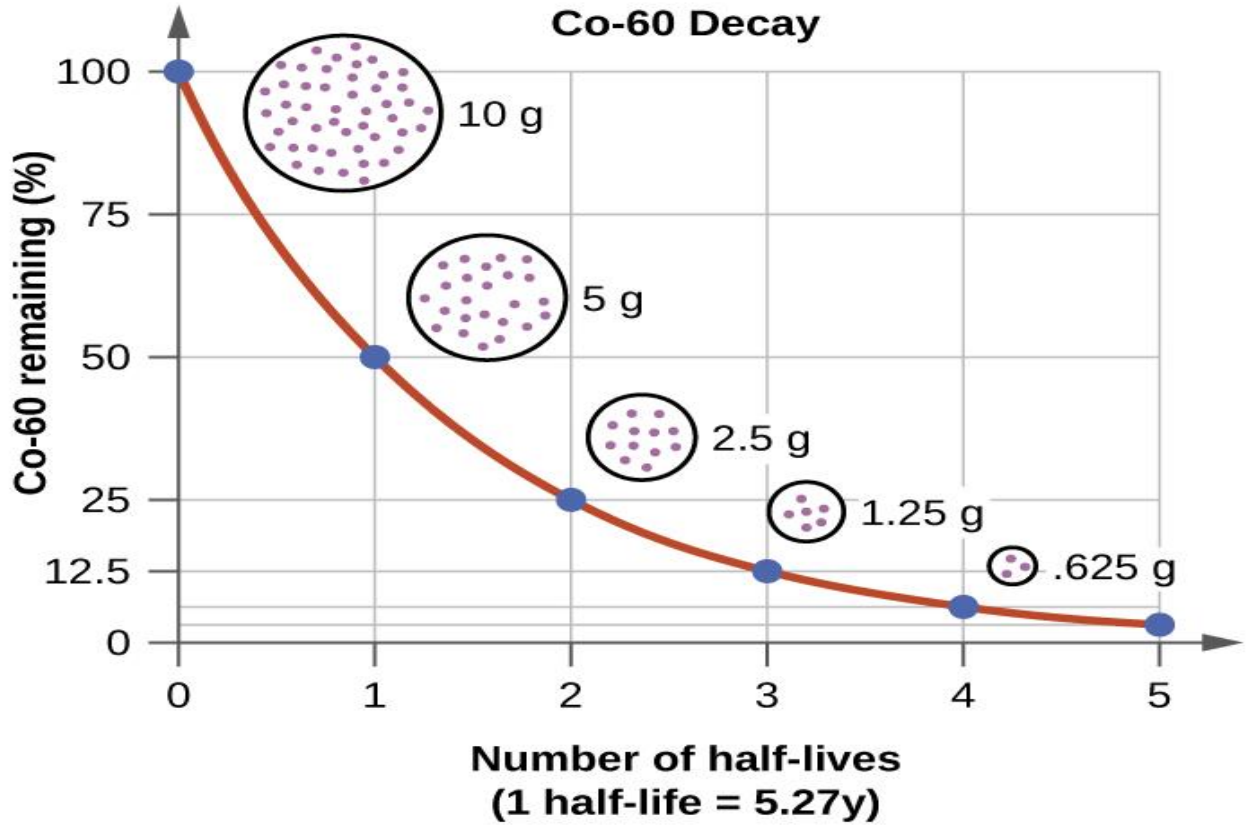
Radiation and radioactivity

The SI unit of measurement for activity is the becquerel (Bq).

- It is a measure of the quantity of radioactive material, but does not indicate how many, or what type of emissions are being released from the nucleus.
  - The Bq is equivalent to one nuclear disintegration per second.
- Activity Concentration relates to the concentrations of radioactivity within a substance:
  - Solids: Becquerels per gram (Bq/g)
  - Liquids: Becquerels per litre (Bq/l)
  - Airborne: Becquerels per cubic metre (Bq/m^3)

Radiation and radioactivity: Half life ($T_{1/2}$)

- The length of time for half of a given quantity of radioactive atoms to undergo radioactive decay
- The half life is constant for a specific radionuclide.



Radiation and radioactivity: Measurement

Radiation doses are a function of the transfer of energy to the body, and are measured by 3 fundamental parameters:

1. **Exposure**
   - Measured in coulombs per kilogram (C/kg)
2. **Absorbed dose**
   - Measured in grays (Gy)
   - In mining applications, dose rate is measured in microGrays per hour (uGy/h)
3. **Dose equivalent**
   - Measured in Sieverts (Sv)
   - It makes allowance for the type of radiation (the Quality Factor) and the radio-sensitivity of the part of the body exposed
   - In mining applications, dose equivalent is measured in milliSieverts (mSv)

Radiation dose and risk

Dose Equivalent (mSv)	Effect
10,000	100% mortality
6,000	Early death
4,000	50% mortality
2,000	Threshold for early death
500	Nausea & reduced white blood cell count
131	NATURAL annual background $dose_{peak}$ in Ramsar, Iran
100	Limit for exposure of a radiation worker over a 5 year period.
20	Derived Limit for exposure of a radiation worker in 1 year*
5	Whole body CT scan, single
2	Average annual exposure from NATURAL radiation
1	Limit of exposure of a 'member of the public' in a single year
0.05	Exposure from 7 hour flight
0.02 – 0.10	Typical sequence of chest x-rays

Radiation exposure and risk

ARPANSA (2018) states:

- Risk from chronic exposures (as occur in the mining industry)

  = 1 in 20,000 per mSv

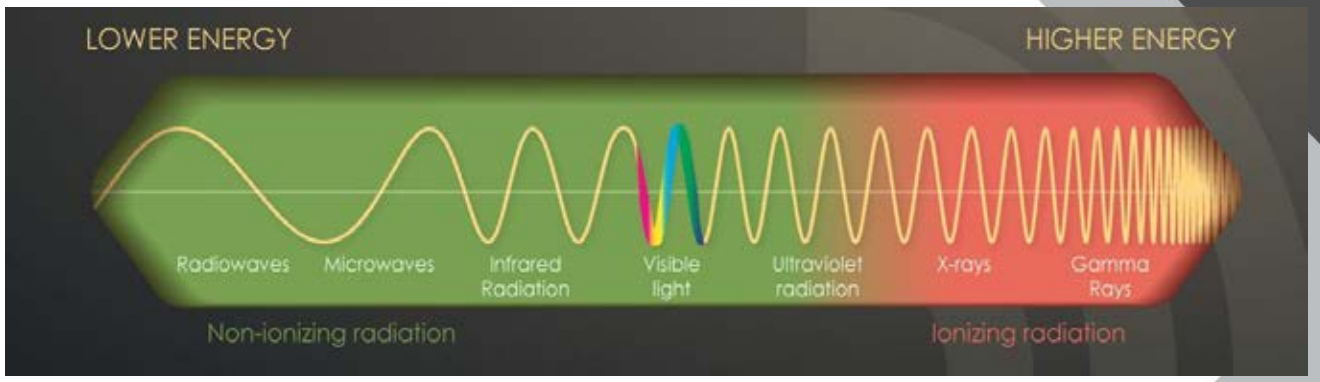
  - Therefore, at 20 mSv annual derived limit, risk is equivalent to **1 in 1000**

- United Kingdom Health and Safety Executive risk model* suggests that this level of risk is intolerable …

*Cited in Hopkins, Safety Culture and Risk: the organisational causes of disasters (2005)

Ionizing radiation from NORs

- Electromagnetic
  - X-rays; or
  - Gamma (γ) rays

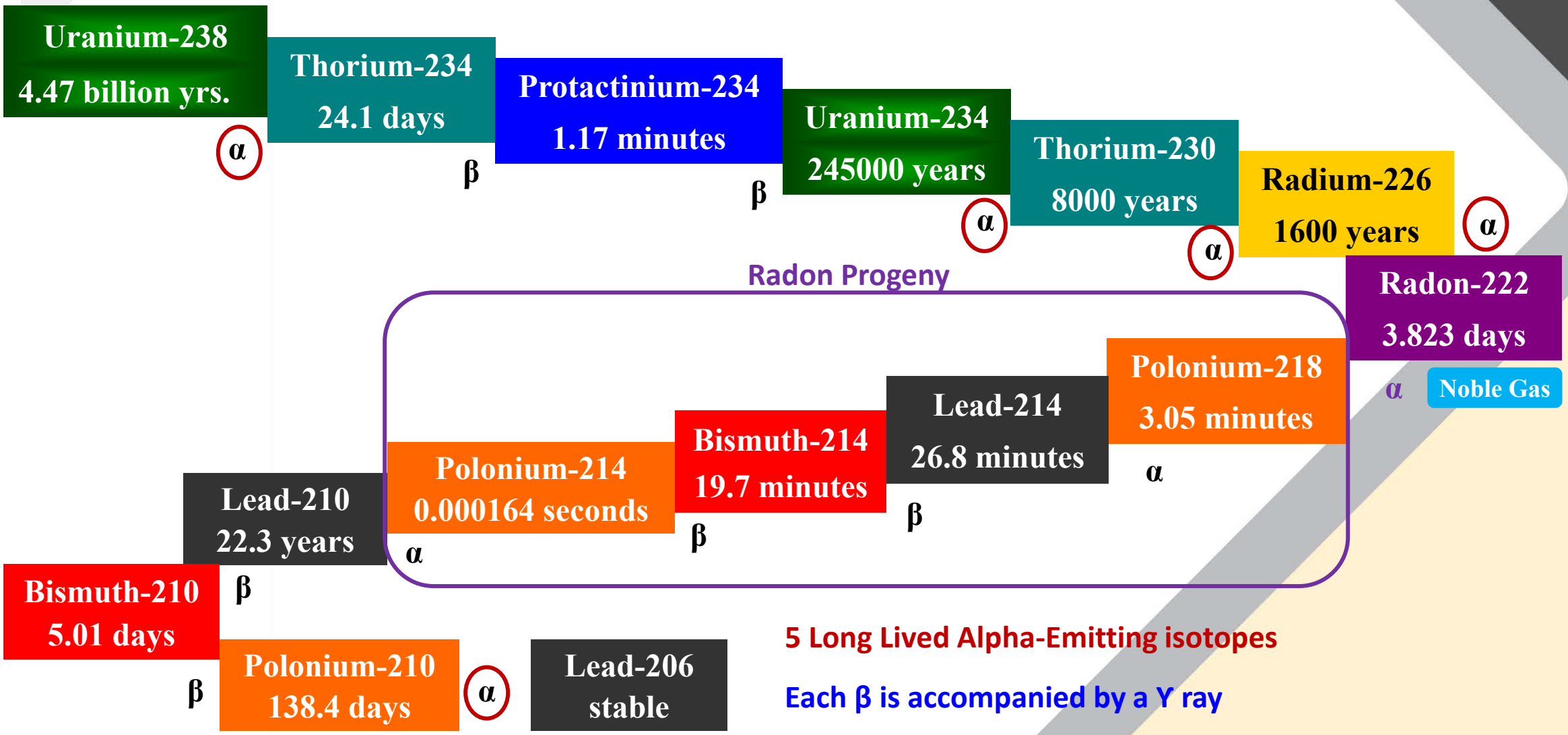


- Particulate
  - Alpha (α) particles
    - Ionised Helium Nucleus ($_2He^{4\,++}$)
  - Beta (β) particles
    - High Speed electron from neutron ($_0n^1$) decay

What are mining NORs?

- The primordial radionuclides
  - Uranium (^{238}U series) and
  - Thorium (^{232}Th series)
- Naturally radioactive
- Heavy metal toxins
  - Will cause death by poisoning before inducing harm via radioactivity
- Consist of complex series' including many radioactive decay products

NOR: The U-238 decay series



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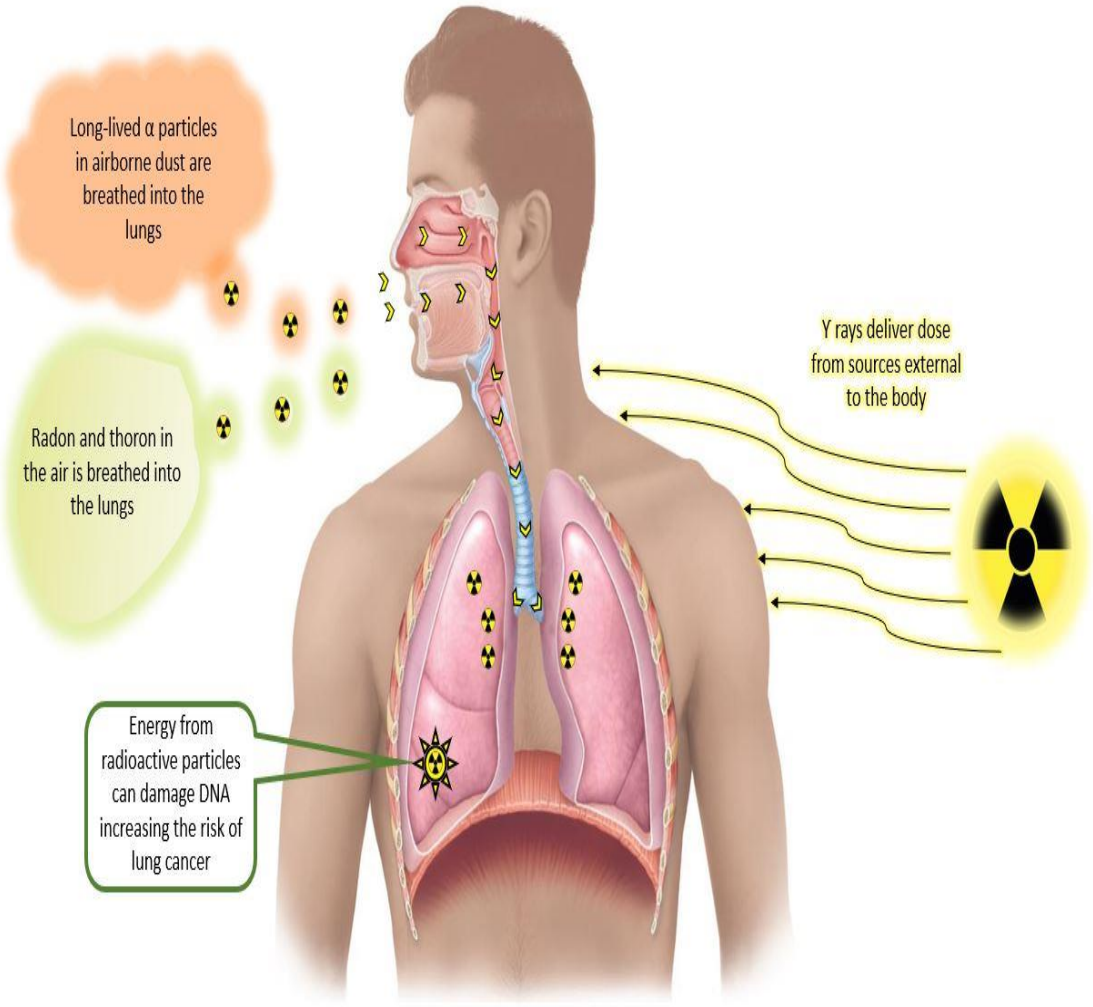
  - Thorium (^{232}Th series)
- Naturally radioactive
- Heavy metal toxins
  - Will cause death by poisoning before inducing harm via radioactivity
- Consist of complex series' including many radioactive decay products
- Occur in trace concentrations in rocks & soils in the earth's crust
  - WA's geology is replete with minerals that contain ^{238}U and ^{232}Th
  - Darling Scarp 10 x more activity than the global crustal average

Why is NORM important?



- *'In the past the mining and extraction industries have been associated with the highest individual occupational exposures to [NORs]'*
- Excess of cancer incidence and / or respiratory system illness observed in studies of mine workers around the world…

Steinhausler (1993)

The 1970s and 80s experience in WA

- In the mid to late 1980s the maximum dose in the mining industry in WA was **~165 mSv**
- and the mean dose, received by 270 designated radiation workers was **31 mSv**
- 80% of the dose was delivered via inhalation of Long Lived Alpha particle emitters in radioactive dusts.
- Rn, Tn and their progeny were not included in dose estimates!

The 1970s and 80s experience in WA

- *The discovery that tailings from a mineral sands processing plant had been used as landfill in Capel, a town in southern Western Australia, indicated the need for a survey of the gamma radiation levels within the town site.*
  - *Eleven houses were found to have elevated backgrounds and a further 27 residential properties had elevated levels outside the house.*
  - *The highest dose rate recorded in a residential area was 4µSv per hour**

Radioactivity in mineral sands in Western Australia

King, Toussaint and Hutchinson (1983)

* Equivalent to approximately 35mSv per year.

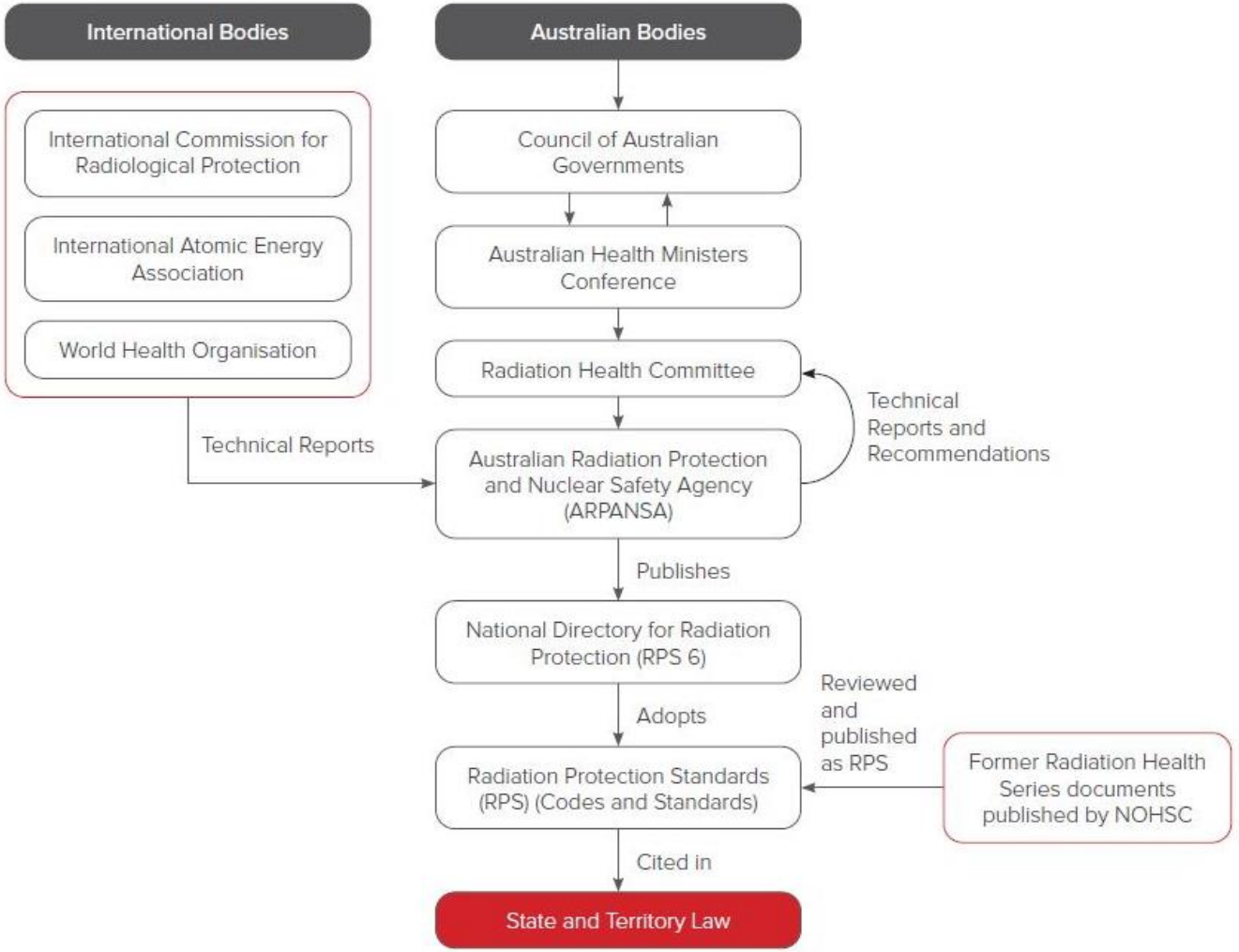
The annual limit for a member of the public is 1mSv.

The radiation protection framework

IAEA General Safety Requirements: Radiation protection and safety of radiation sources (GSR3, 2014)

2.14. The government shall ensure that adequate arrangements are in place for the protection of people and the environment, both now and in the future, against harmful effects of ionizing radiation, without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks. This shall include arrangements for the protection of people of present and future generations and populations remote from present facilities and activities.

Australian regulatory framework



DCCEEW

Dept. of Climate Change, Energy, the Environment and Water

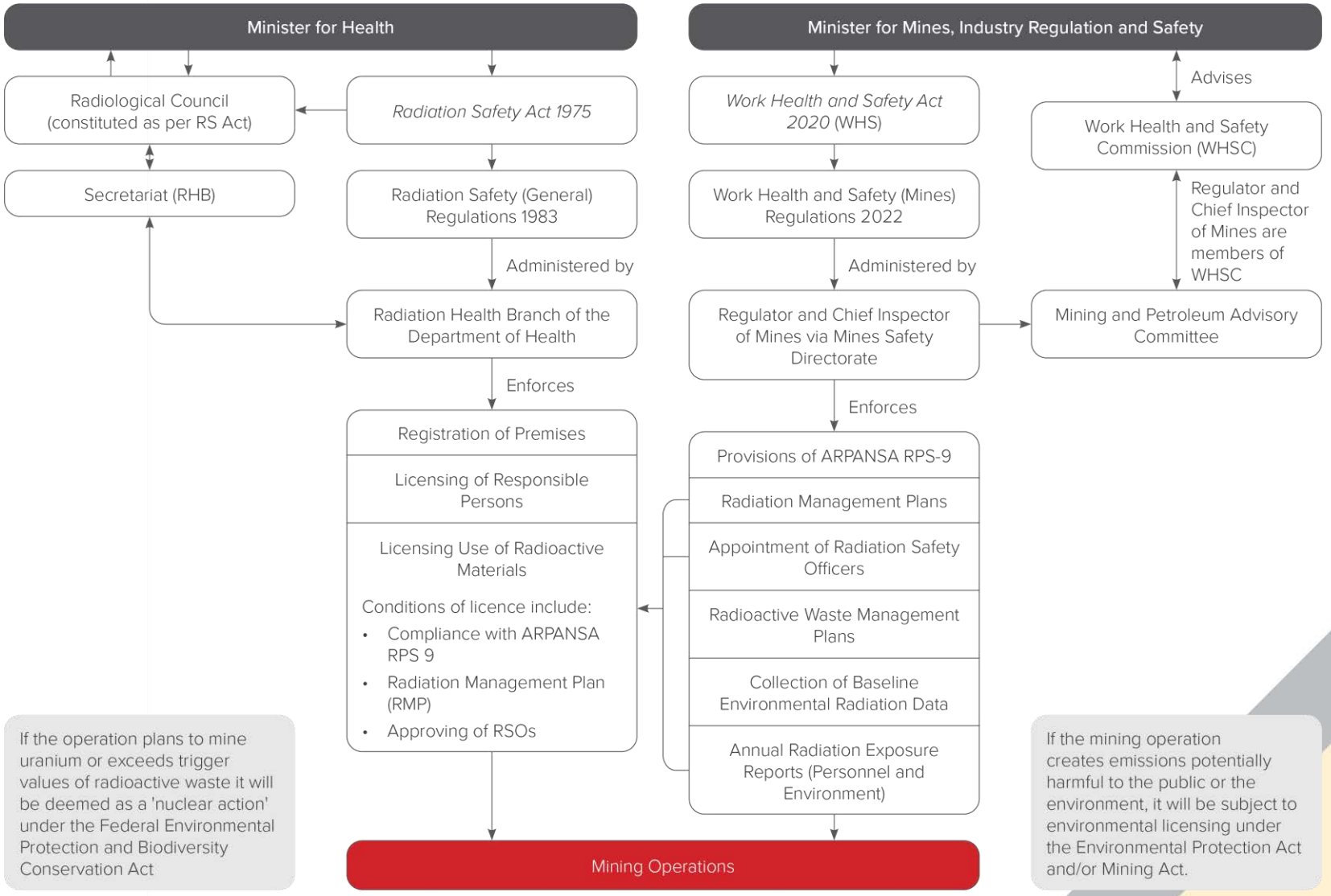
EPBC Act

Nuclear Action

ASNO

Australian Safeguards and Non-Proliferation Office

West Australian regulatory framework



WHS (Mines) regulations: Overview

NORM Covered in Part 10.2, Division 3, Subdivision 3B

Regulations 641I to 641Y

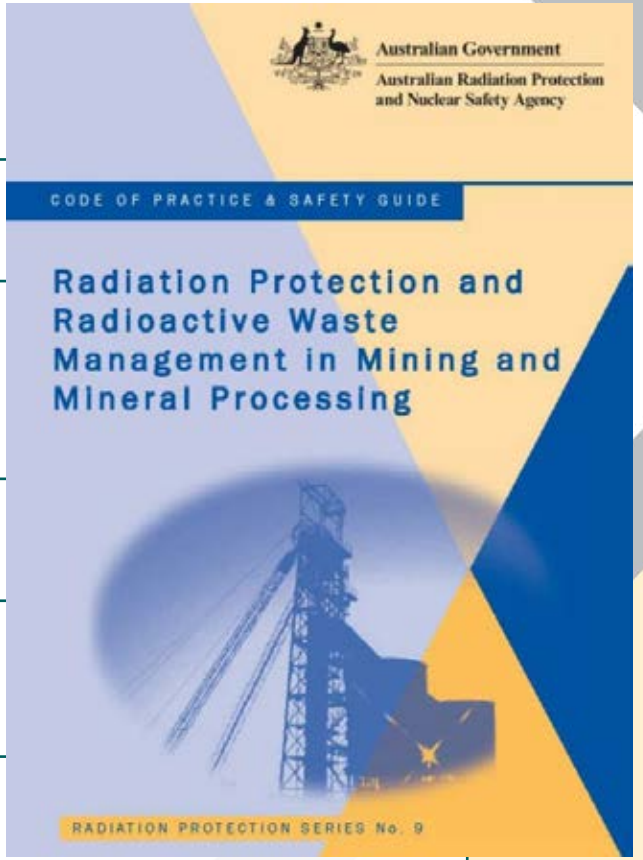
Risk based approach to application of regulations:

Radioactivity criteria and worker (public) dose criteria

Invokes Federal ARPANSA document RPS-9

Invokes national dose limits

- Radiation Management Plan (RMP)
- Radioactive Waste Management Plan (RWMP)
- Radiation Safety Officer (NORM).



r.641K – Meaning of radioactive material

Actvity concentration >= 1 Bqg^{-1}.

Any part of the mining process, including residues and tailings streams …

All mineral sands products exceed the 1 Bqg^{-1} criteria …

Operations pursuing rare earth or pegmatite-hosted lithium minerals may exceed the 1 Bqg^{-1} criteria …

WHS (Mines) regulations - r.641L

Risk-based approach applies to radiation protection regulations

If the 1 Bqg^{-1} is exceeded, doses to workers or public must be likely to exceed the limits in r. 641L (b)(i) or (ii) for the regulations to apply

Onus is on the mine operator to demonstrate to the regulator:

Radioactive materials are not encountered; and

Doses to workers are not likely to exceed 1 mSv per year; and

Doses to the public are not likely to exceed 0.5 mSv per year.

WA's regulatory framework

WHS (Mines) Regulations based on international better practice

Supported by the NORM Guidelines:

- NORM-V: Dose assessment
  - Adopted across Australia and internationally
- NORM-II: Radiation management plans and radiation safety officers
  - norm-ii_draft_for_consultation.docx (live.com)
- NORM-VI (Waste) and NORM-I (Reporting) next in line…

Challenge #1: WA's critical minerals sector

Most rare earths deposits in WA contain NORs (some very elevated)

168 WA-based, ASX-listed mining companies with REE in their portfolio

(https://stockhead.com.au/resources/bargain-barrel-10-cheap-asx-rare-earths-stocks-to-jump-into-right-now)

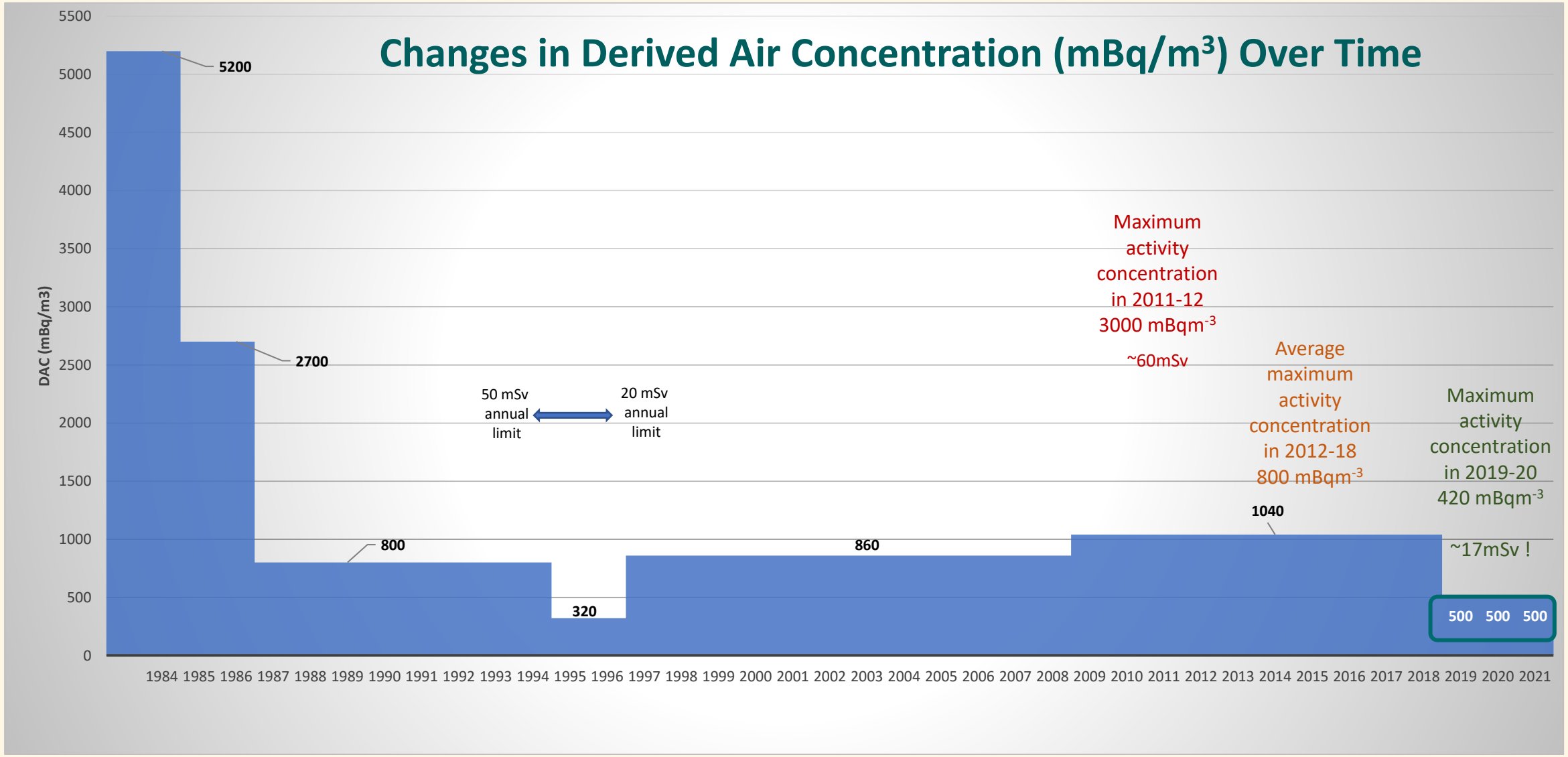
54* exploration operations have made announcements since 1/7/2022… meaning geologists and exploration teams are in the field now!

* As at 25/3/2023

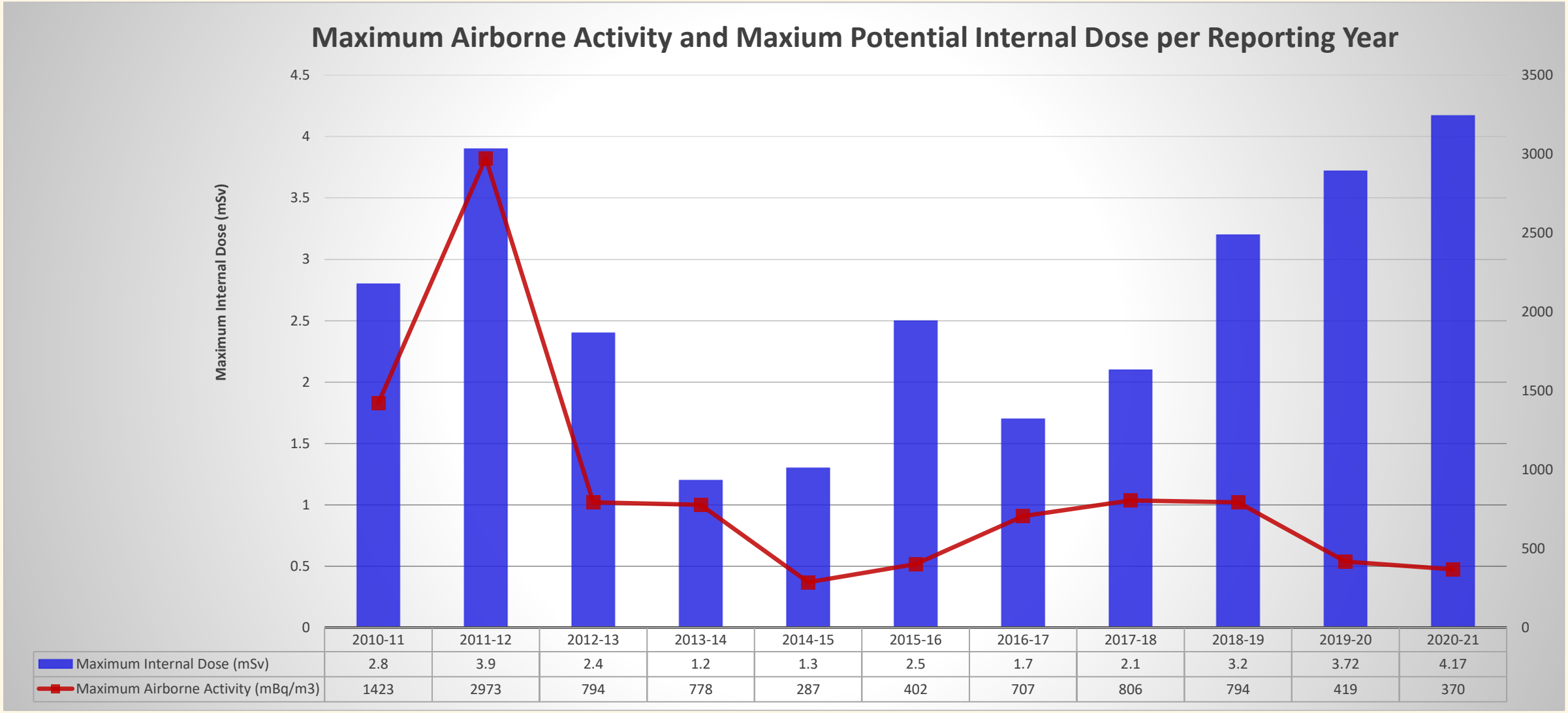
Challenge #2: Internal dose risk factors

- International authorities have reviewed risk factors from inhalation of NORs.
- Mines Safety forecast WA worker doses will double because of the revisions.
  - The mean dose from the 1980s would be 55 mSv
  - Nearly 3 times the derived annual limit for workers!
- Designated workers in the mining industry for the first time since early 2000s.

Challenge #2: Impact on DACs

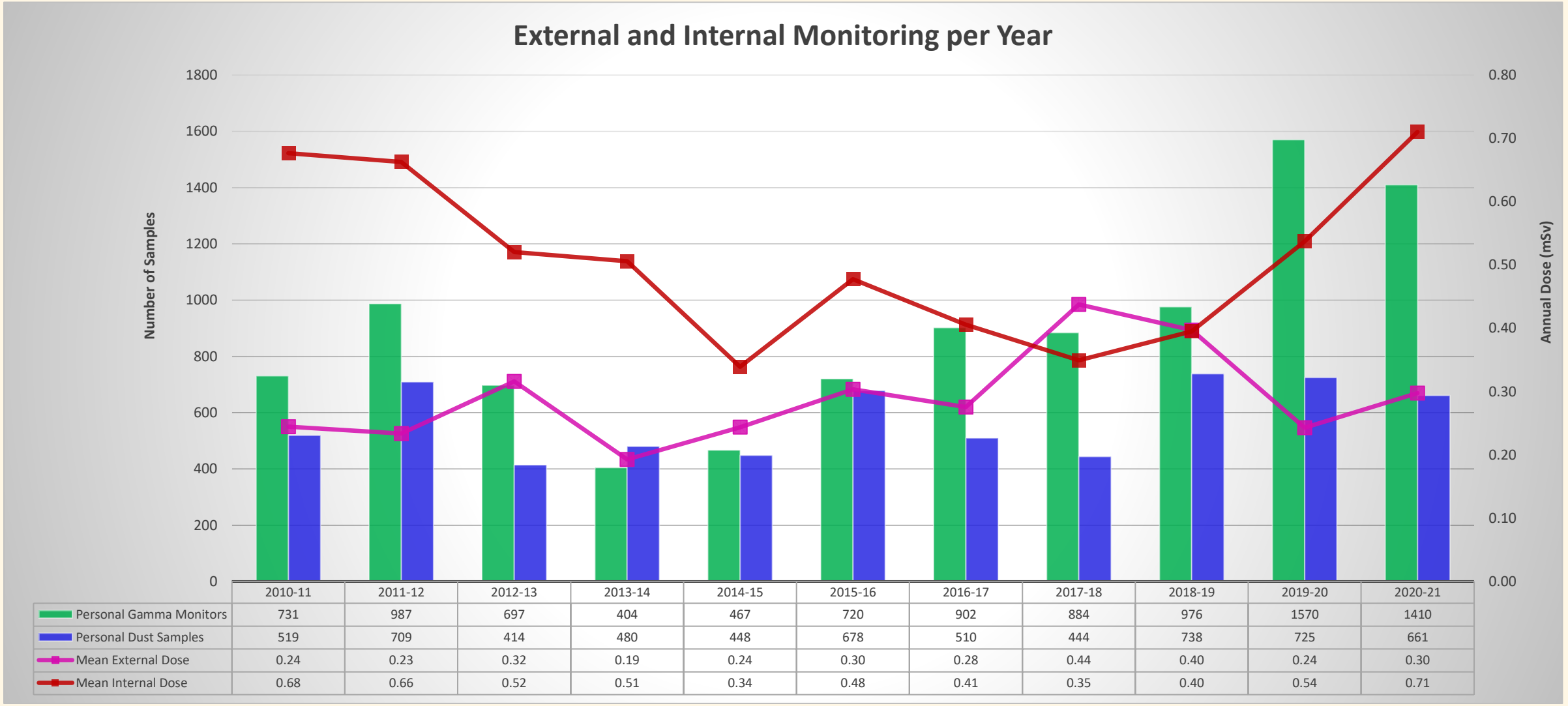


Challenge #3: A bifurcation



	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Maximum Internal Dose (mSv)	2.8	3.9	2.4	1.2	1.3	2.5	1.7	2.1	3.2	3.72	4.17
Maximum Airborne Activity (mBq/m3)	1423	2973	794	778	287	402	707	806	794	419	370

Challenge #4: Inappropriate monitoring?



	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Personal Gamma Monitors	731	987	697	404	467	720	902	884	976	1570	1410
Personal Dust Samples	519	709	414	480	448	678	510	444	738	725	661
Mean External Dose	0.24	0.23	0.32	0.19	0.24	0.30	0.28	0.44	0.40	0.24	0.30
Mean Internal Dose	0.68	0.66	0.52	0.51	0.34	0.48	0.41	0.35	0.40	0.54	0.71

For more (detailed) information

Given the rapidly changing geopolitical landscape for the supply of critical minerals (including uranium) and WA's unique lithology:

"What is the potential for radiation exposures from NORs to the significant increased workforce, and is the regulatory framework fit-for-purpose to ensure radiation doses are kept as low as reasonably achievable?"

MR's Research Thesis

Towards establishing a fit-for-purpose regulatory framework for radiation protection in Western Australia's mining industry: Evaluating mine worker exposures to naturally occurring radionuclides.

at https://ro.ecu.edu.au/theses/2642

Key references

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- Safe Work Australia. Guide to managing risks of exposure to diesel exhaust in the workplace. 2015, Safe Work Australia: Canberra, ACT.
- Steiner, S., Bisig, C., Petri-Fink, A., Rothen-Rutishauser, B. Diesel exhaust: current knowledge of adverse effects and underlying cellular mechanisms. Arch Toxicol. 2016;90(7):1541-53

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GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Breathing easy beyond the workplace: The interplay between WHS and public health

Pierina Otness

Senior Toxicologist
Environmental Health Directorate
Department of Health

Topics

The principles underpinning legislation and policy

Example health hazards in common

- Asbestos
- PFAS
- Metals
- Moulds and viruses

Risk management

Risk communication

WHS Act - Guiding principle

- Workers and other persons should be given the highest level of protection against harm to their health, safety and welfare from hazards and risks arising from work, so far as is reasonably practicable.

Public Health Act guiding principles

Precautionary principle

- If there is a public health risk, lack of scientific uncertainty should not be used as a reason to postpone measures to prevent, control or abate that risk.
- In applying the precautionary principle decision making should be guided by:
  - careful evaluation to avoid, where practicable, harm to public health, AND
  - an assessment of the risk-weighted consequences of the options.

Principles…

Sustainability principle

- Our decisions and actions not only benefit people today, but do not have adverse consequences for future generations.
- Practices and procedures must be cost effective and in proportion to the significance of the public health risks and consequences being addressed.

Principles…

Principle of proportionality

- Decisions and responses should be made proportionate to the public health risk to be prevented, controlled or abated
- Decision-making and action taken should apply measures that have the least adverse impact on the individual, business or community.

Principles…

Principle of intergenerational equity

- The present generation should ensure that public health is maintained or enhanced to ensure future generations benefit.

Principle relating to local government

- The functions of local governments in relation to public health should be acknowledged and respected.

Objects

Public Health Act 2016

- Promote and improve public health and wellbeing and to prevent harm
- Provide to the extent reasonably practicable a healthy environment for all
- Promote provision of information to individuals and communities about public health risks
- Encourage individuals and communities to plan for, create and maintain a healthy environment.

WHS Act 2020

- Protecting workers and others against harm to their health, safety and welfare through the elimination or minimisation of risks arising from work
- Providing for fair and effective workplace representation, consultation, cooperation and issue resolution in relation to work health and safety
- Promoting the provision of advice, information, education and training in relation to work health and safety.

Environmental health hazards

Physical, chemical and biological pollutants that can cause harm.

Asbestos

Asbestos – Health (asbestos) regulations

- Sale and supply
  - exemptions: supply for disposal, fixture on land, part of dwelling.
- Can only:
  - maintain or repair the asbestos cement product
  - remove the asbestos cement product for the purpose of disposal
  - reinstatement limited and should be discouraged.

Asbestos regs…

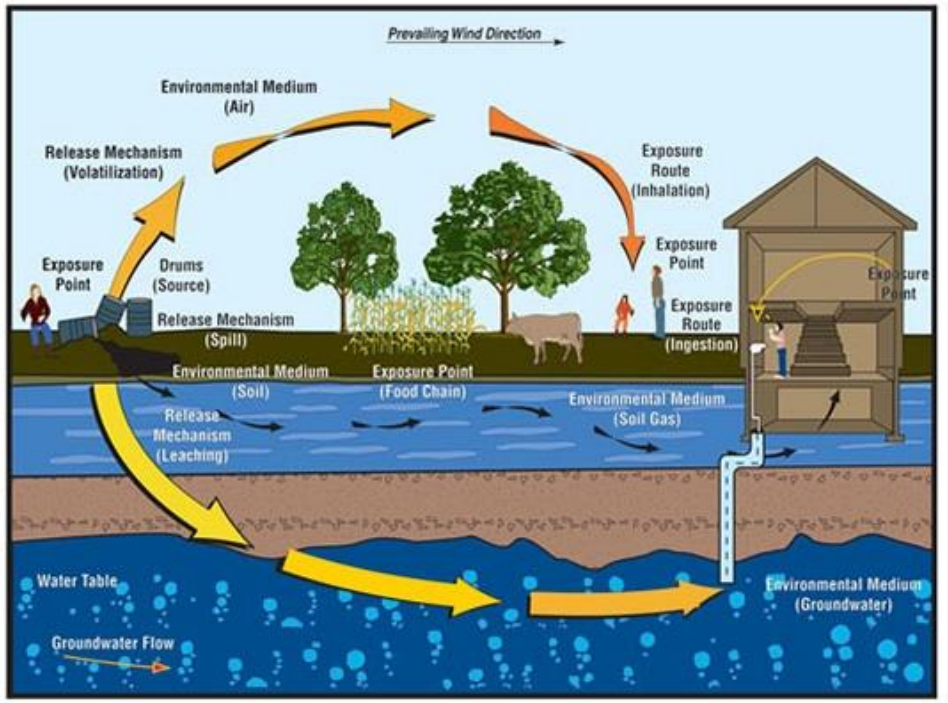
- Regulations aim to minimise exposure to airborne fibres
  - A person who stores, breaks, damages, cuts, maintains, repairs, removes, moves, or disposes of, or uses any material containing asbestos without taking reasonable measures to prevent asbestos fibres entering the atmosphere commits an offence.

Asbestos regs…

- Local Government Authority may give direction to **maintain**, **repair**, **remove**, **move**, **dispose** of, or **handle** the material containing asbestos in such **manner** and within such **time** as is specified in the direction.
- Appropriate waste separation, containment, transport and disposal.

Contamination of the environment

- Industrial emissions and discharges
  - Air emissions
  - Contamination of groundwater
- Land use and planning
  - Change in land use
- Source – exposure pathway – receptor
  - Exposure pathways:
    - Water use
    - Inhalation of vapour
    - Consumption of homegrown produce, livestock, eggs
    - Direct soil/water contact



Source: Example of a Site Conceptual Model Schematic (cdc.gov)

Contaminated sites - PFAS

- PFAS are per- and polyfluoroalkyl substances, a group of over 4000 chemicals.
- Used in a range of applications as effective at resisting heat, stains, grease and water.
- Everyone has had some exposure to PFAS.
- Persistent, bio accumulative, evidence of adverse effects.

PFAS

- Evidence of health effects is limited with regard to disease causation. Research shows associations with changes in cholesterol levels, kidney functions and hormones
- Persistent pollutants take a long time to break down in the environment and human body
- Increased levels of PFAS found near
  - Fire training grounds
  - Effluent outfalls
  - Landfill sites.

PFAS

- Approach is to minimise exposure.
- Health based guidance values established for PFOS, PFOA, PFHxS.

Perfluorinated chemicals in food | Department of Health and Aged Care
https://www.health.gov.au/resources/collections/perfluorinated-chemicals-in-food

PFAS Health Study | National Centre for Epidemiology and Population Health
https://nceph.anu.edu.au/research/projects/pfas-health-study

Metals (and particulates)

- Source may be work or other activities outside of work
  - Business activities on residential property
  - Hobbies (pottery, lead lighting, fishing, shooting, welding)
  - Plumbing fixtures
  - Work clothing/equipment
  - Home renovation.

HealthyWA Health information for Western Australians https://www.healthywa.wa.gov.au/

Advice for plumbing practitioners on the new lead requirements https://abcb.gov.au/news/2022/advice-plumbing-practitioners-new-lead-requirements

Metals

- Use best practice
  - Wear coveralls
  - Shower and change before leaving work
  - Use workplace laundering facilities where provided
  - Place in sealed bag and wash separately
  - Isolate “dirty” hobby or work areas at home from clean play/living areas – use appropriate PPE, maintain good housekeeping, clean up accumulated dust, dispose of waste appropriately
  - Do not eat, drink or smoke in the work area
  - Model good practices when undertaking hobby or renovation activities.

Indoor air quality

- Ventilation
- Comparison with air quality guidelines
- Mould counts - indoor vs outdoor
- Internal sources important:
  - People
  - Heating and cooking
  - Toilets and bathrooms
  - Chemicals
  - Candles and burners
  - Pets and animals
- Building Code and Australian Standards can be applied

Table FV4.1 Maximum contaminant limits for acceptable indoor air quality

Pollutant	Averaging time	Maximum air quality value
Carbon dioxide, CO_2	8 hours	850 ppm Note 1
Carbon monoxide, CO	15 minutes	90 ppm
Carbon monoxide, CO	30 minutes	50 ppm
Carbon monoxide, CO	1 hour	25 ppm
Carbon monoxide, CO	8 hours	10 ppm
Formaldehyde, CH_2O	30 minutes	0.1 mg/m^3
Nitrogen dioxide, NO_2	1 year	40 $\mu g/m^3$ (0.0197 ppm) Note 2
Nitrogen dioxide, NO_2	1 hour	200 $\mu g/m^3$ (0.0987 ppm)
Ozone, O_3	8 hour, daily maximum	100 $\mu g/m^3$(0.0473 ppm)
Particulate matter, $PM_{2.5}$	1 year	10 $\mu g/m^3$
Particulate matter, $PM_{2.5}$	24 hour (99th percentile)	25 $\mu g/m^3$
Particulate matter, PM_{10}	1 year	20 $\mu g/m^3$
Particulate matter, PM_{10}	24 hour (99th percentile)	50 $\mu g/m^3$
Total volatile organic compounds	1 hour	500 $\mu g/m^3$

Notes to Table FV4.1 :

1. Based on body odour metric (i.e. 450 ppm above ambient CO_2 level of 400 ppm and demand control ventilation provisions in AS 1668.2).
2. Based on pressure of 101.325 kPa and temperature of 25°C (i.e. the conversion is mg/m^3 = ppm (molecular weight/24.4)).

Mould

- Moulds are common in buildings, homes and outdoors
- Moisture and dampness are key factors for mould growth
- Health effects can result from different types/colours of mould
- Any visible mould should be removed and the source of moisture dampness fixed

https://www.healthywa.wa.gov.au/Articles/J_M/Mould-and-dampness

Mould at work | Department of Mines, Industry Regulation and Safety (commerce.wa.gov.au)

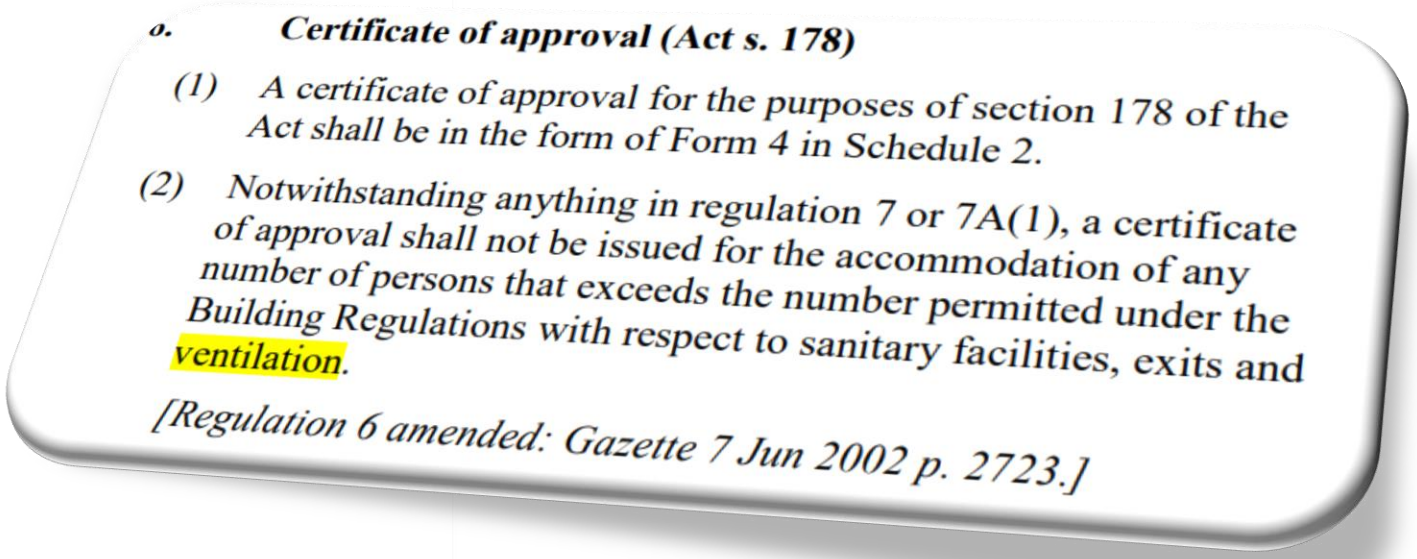
Indoor air quality

COVID-19

Government of Western Australia
Department of Health

Information on COVID-19 and building ventilation

- Learnings from COVID relating to ventilation
- Apply risk assessment and control principles to managing airborne respiratory viruses
- Possible increased role of public health professionals in ventilation



6. **Certificate of approval (Act s. 178)**

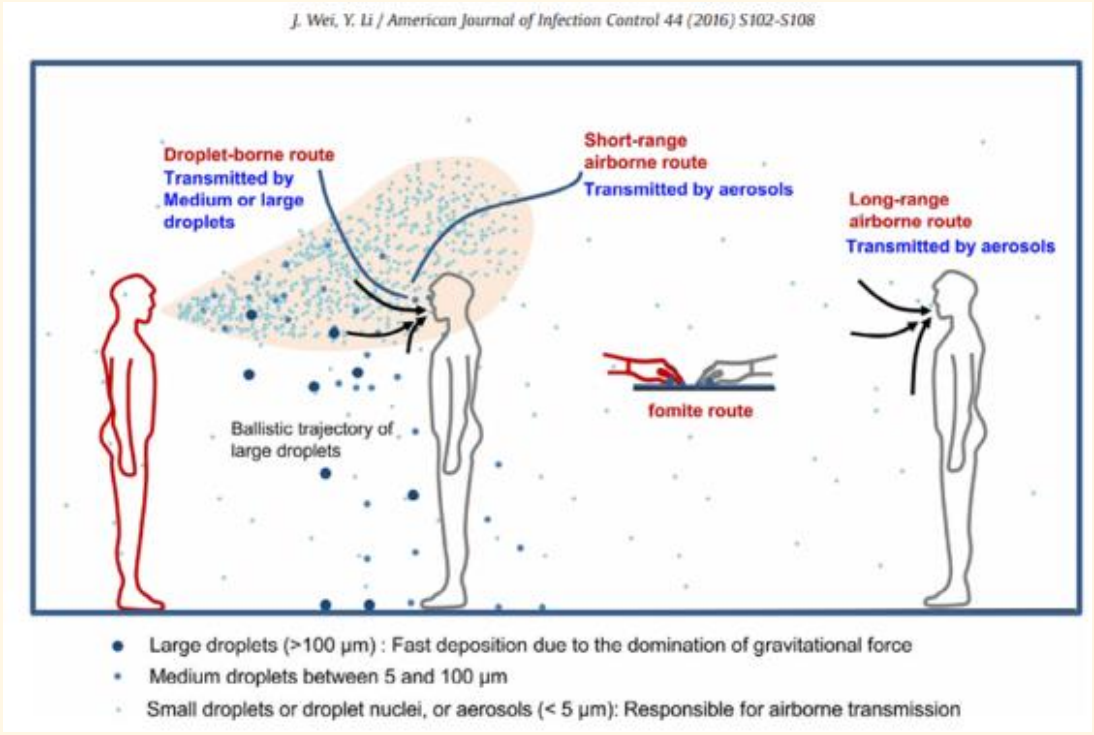
(1) A certificate of approval for the purposes of section 178 of the Act shall be in the form of Form 4 in Schedule 2.

(2) Notwithstanding anything in regulation 7 or 7A(1), a certificate of approval shall not be issued for the accommodation of any number of persons that exceeds the number permitted under the Building Regulations with respect to sanitary facilities, exits and ventilation.

[Regulation 6 amended: Gazette 7 Jun 2002 p. 2723.]

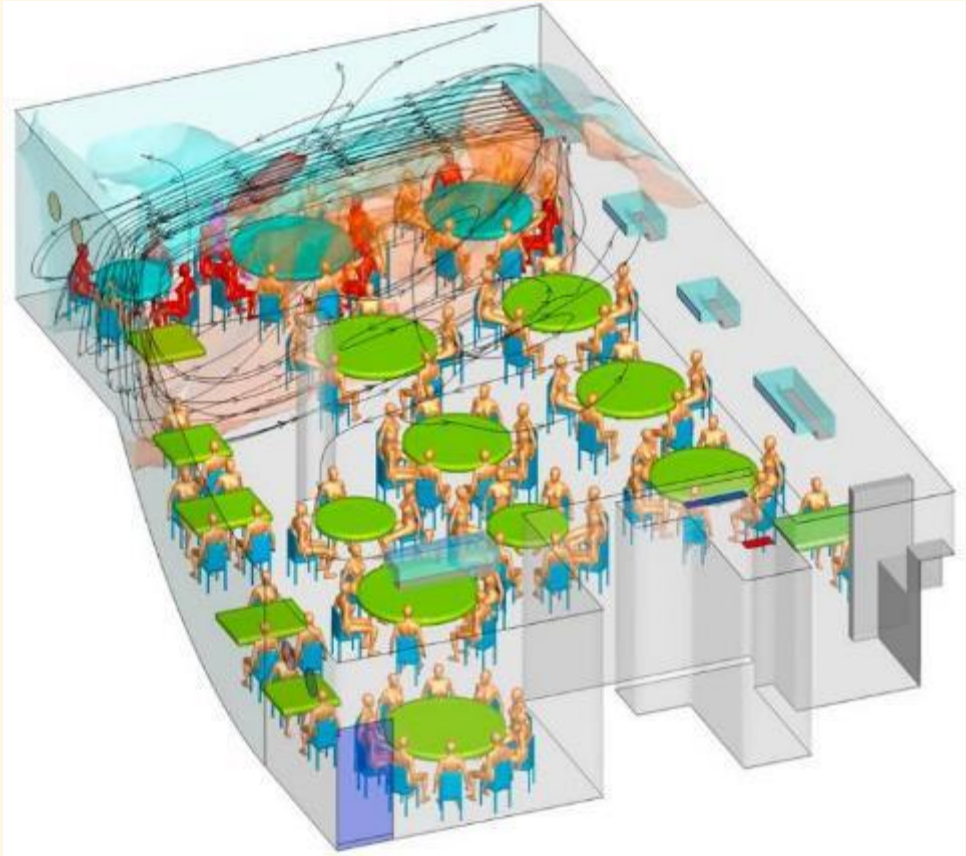
Indoor air quality

- Potential airborne human pathogens – microbial aerosols
  - Bacteria, viruses
  - Human occupancy and ventilation are primary sources of dispersal
  - No established IAQ guidelines
- Airborne viruses - close contact facilitates multiple transmission pathways
  - highest risk of becoming infected



Indoor transmission – airborne pathogens

- Inhalation pathway is a mode of transmission of respiratory viruses
- Cannot reliably predict conditions under which such transmission may occur
- But - can still protect the inhalation pathway and reduce relative risk where transmission can be reasonably expected to occur

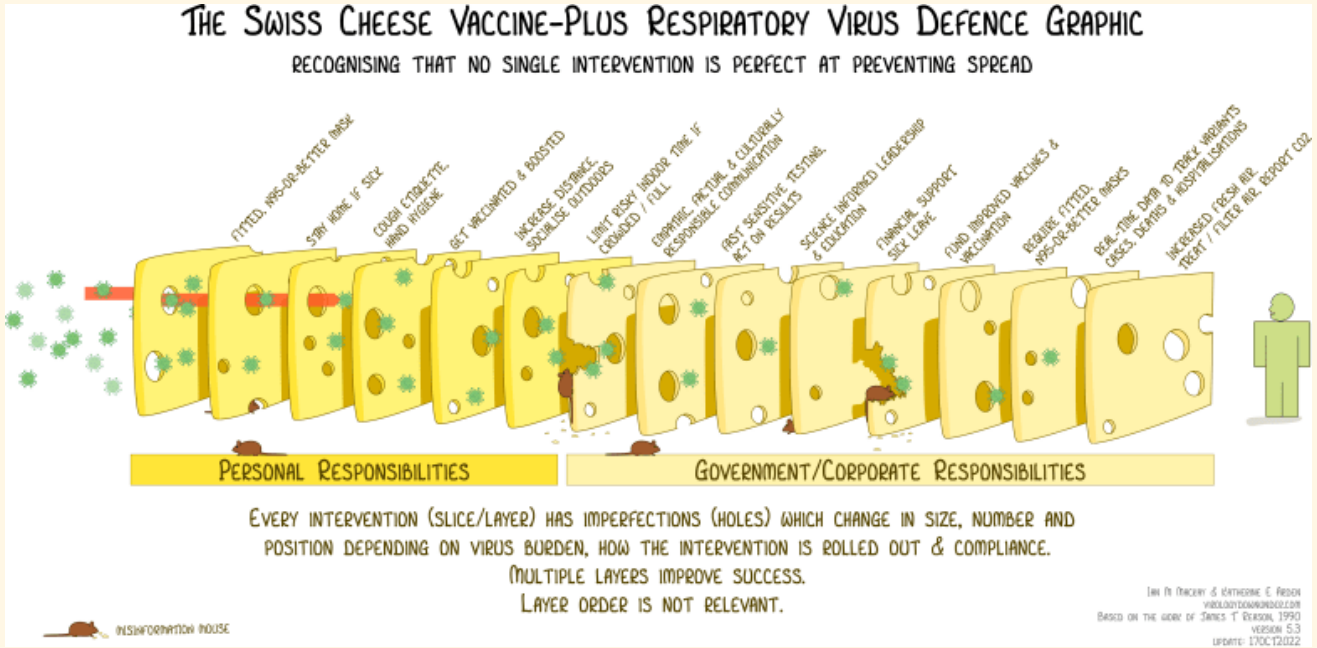


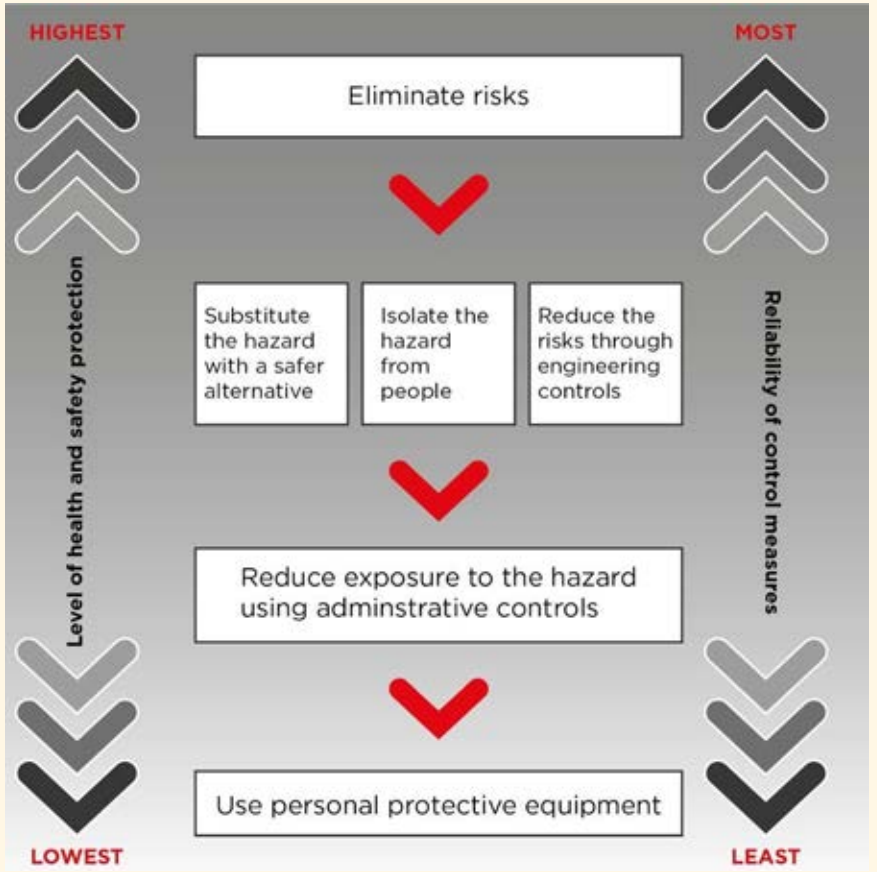
Li Y, Qian H, Hang J, et al. Probable airborne transmission of SARS-CoV-2 in a poorly ventilated restaurant. Build Environ. 2021;196:107788. doi:10.1016/j.buildenv.2021.107788

Risk management

- Apply hierarchy of control.
- Combine interventions.
- Use decision making principles.

James Reason's Swiss Cheese model adapted by Dr Ian Mackay
[The Swiss cheese infographic that went viral - Virology Down Under]

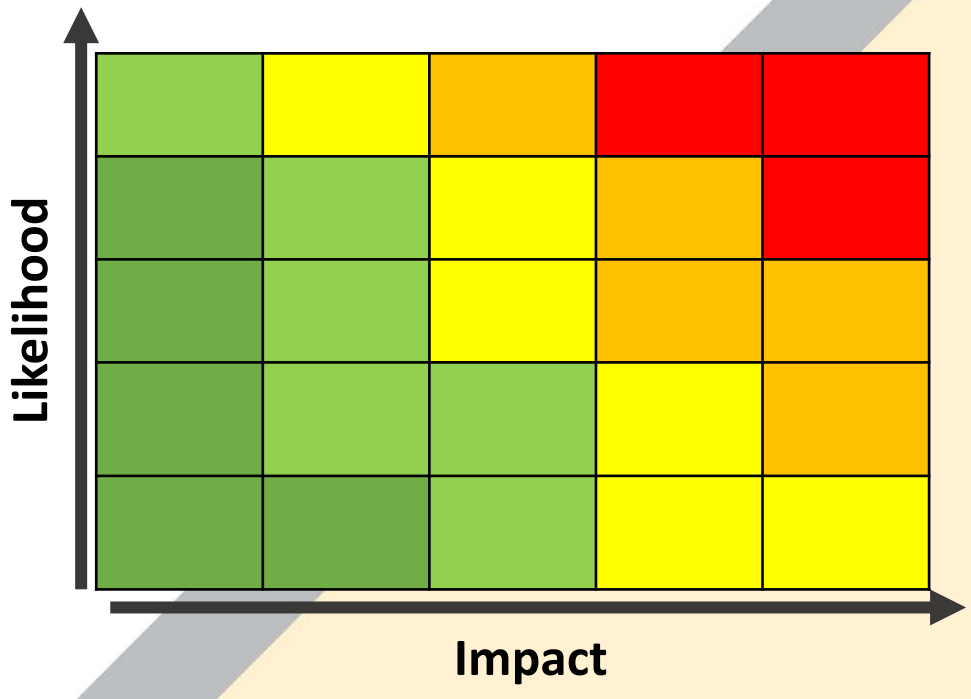




https://www.safeworkaustralia.gov.au/safety-topic/managing-health-and-safety/identify-assess-and-control-hazards/managing-risks

Risk communication

- Risk communication may be difficult in both settings
- Need to distinguish between “hazard” and “risk”
- Beyond exposure (likelihood) and consequence - factors affecting our evaluation of a risk:
  - Familiarity;
  - Voluntary vs involuntary;
  - Tolerance to risk;
  - Children as receptors;
  - Manufactured vs natural ;
  - Fairness; and
  - Immediate vs later effects.



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GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Lunch

The closure of Wittenoom - demolition works in an asbestos contaminated environment

Joshua Caccetta

Director – Property and Risk Management
Department of Planning, Lands and Heritage

and

Samuel Jackson

Director – Thuroona Services

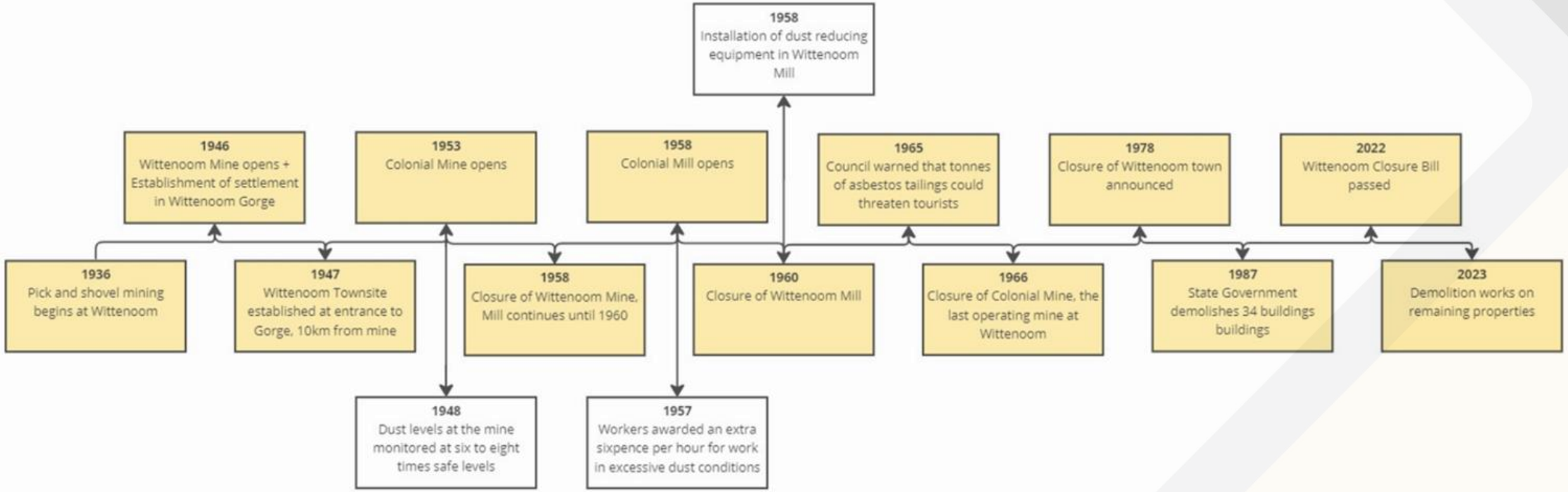
Joshua Caccetta

Director – Property and Risk Management

Department of Planning, Lands and Heritage

Wittenoom townsite

History of mining and asbestos in Wittenoom



Early dust issues

SAFETY

Wittenoom deadly dust "hell-hole"

by Joyce Slater

A former mill worker at Wittenoom mine described it as a hell-hole in the WA Supreme Court last week. Stanley Wade said that, at night, the mine and mill area looked like blue fluorescence as large lamps lit up the asbestos dust.

He said that special air filters needed changing every four hours. Face masks were useless because it was hot and when the men sweated, their masks filled up with a muddy mix of sweat and dust.

He said he once saw a man having a terrible time clearing up the dust that poured from a hole in the ducting system.

Lawyer David Ashley, representing former Wittenoom worker Wally Simpson, who is claiming damages from Midalco, said he would show that the mine filter system was inadequate and that dust-filled air from the mill was drawn into the mine.

Three former underground workers told the court that the mine areas were ventilated by a fan which sucked air along a canvas tube to the mine faces. They allege the air was which were already polluted with dust from inside the mine, and from the mill outside the mine.

The canvas tubes often had holes, maintenance work was slow, and ventilation officers used a roll of twine and a needle to repair the holes.

Graham Cooper, a former mine surveyor for Australian Blue Asbestos at Wittenoom in early 1960, said he was at a meeting between senior mines inspector Jack Boyland, Mines Department ventilation officer Ian Loxton, Wittenoom mine general manager Ozzie Allan, mine manager Kevin Parker, the mine geologist and shift bosses.

"Boyland has some data on dust counts and other things, like that asbestos was very dangerous and worse than silica. He said he was going to close down the mine."

Cooper said Boyland laid down a list of safety requirements needed if the mine was to stay open. They included monitoring dust levels and using a lot of water to try to control the dust menace.

He said that when Boyland and Loxton left the meeting, Ozzie Allan and Kevin Parker told the mine officials that what they had heard "must not go outside the room". The

Transport of asbestos bags

- Processed asbestos was transported in hessian bags on open flat bed trucks between Wittenoom and Point Sampson from the 1940s until the 1960s.
- It was not uncommon for bags to fall off trucks and be left. The hessian having since degraded leaving large localised asbestos deposits.
- These impacts are now present on road surfaces and shoulders throughout the area.

Wittenoom asbestos management area (WAMA)

- The WAMA is the area surrounding Wittenoom that has been declared as contaminated and requiring further technical review.
- It is the largest contaminated site in the Southern Hemisphere, at 46,840ha, having been formerly classified under the *Contaminated Sites Act 2003*.
- The underlying land tenure of the WAMA is a mix of Crown land being, roads, reserves, leases and unallocated Crown land.
- The Banjima People hold the native title rights for the area as the recognised traditional owners.

Townsite acquisition and demolition

- Last rounds of negotiations were held for landowners to sell land holdings, but full agreement was not able to be reached.

- A special act of Parliament was required to enable compulsory acquisition of the last remaining freehold – *The Wittenoom Closure Act 2022.*

- Following acquisition DPLH progressed to tendering for demolition works for the remaining above ground infrastructure within the former townsite. Noting that this was for demolition works and not a remediation project.

- A key criteria was the consideration of WHS protocols, WHS management and WHS documentation, including a focus on dust suppression during the demolition works.

- From the tender evaluation, DPLH appointed Thuroona Services to undertake the townsite demolition works.

GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

The closure of Wittenoom and demolition in asbestos contaminated environments

Samuel Jackson

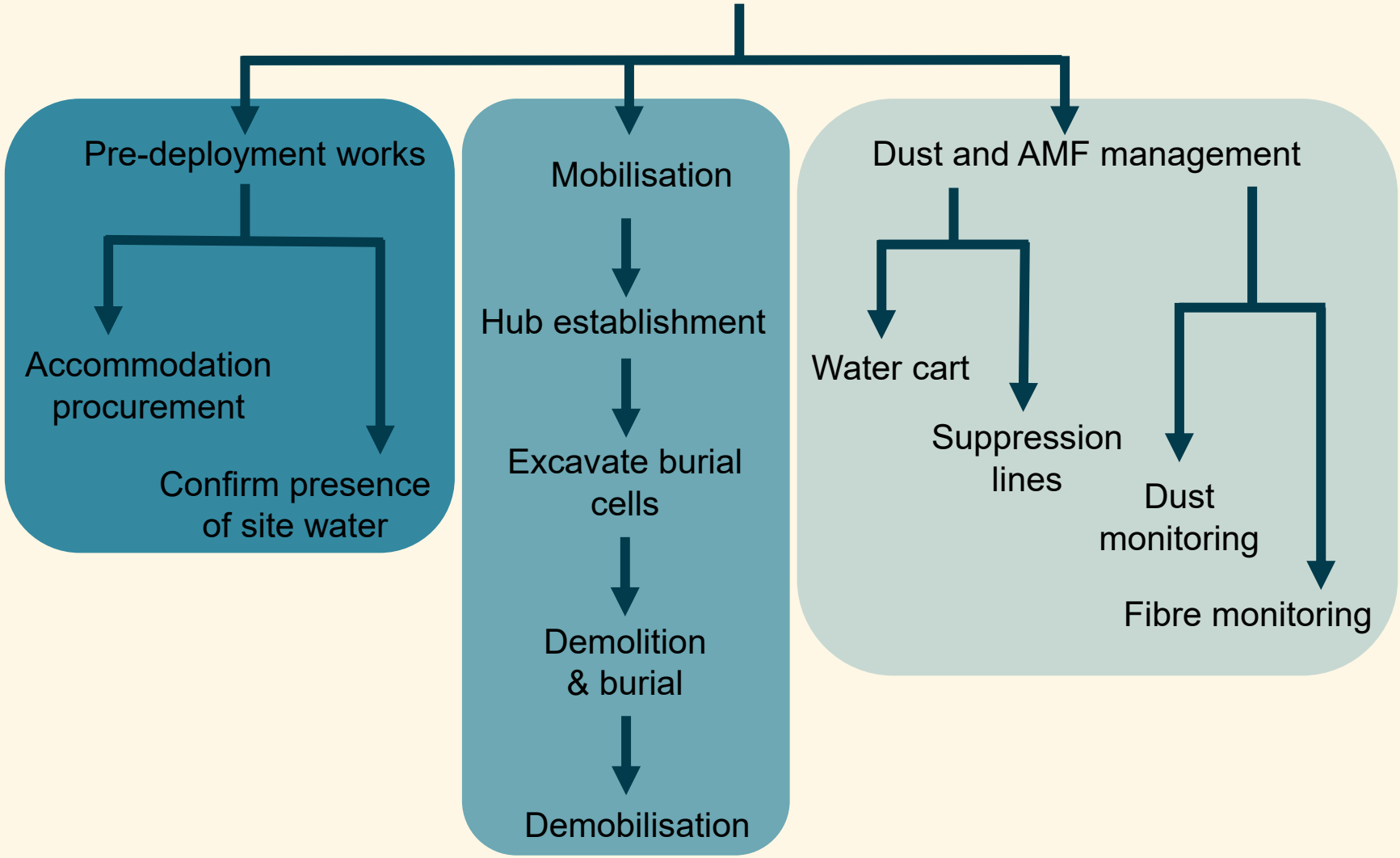
Director – Thuroona Services

Wittenoom townsite demolition project

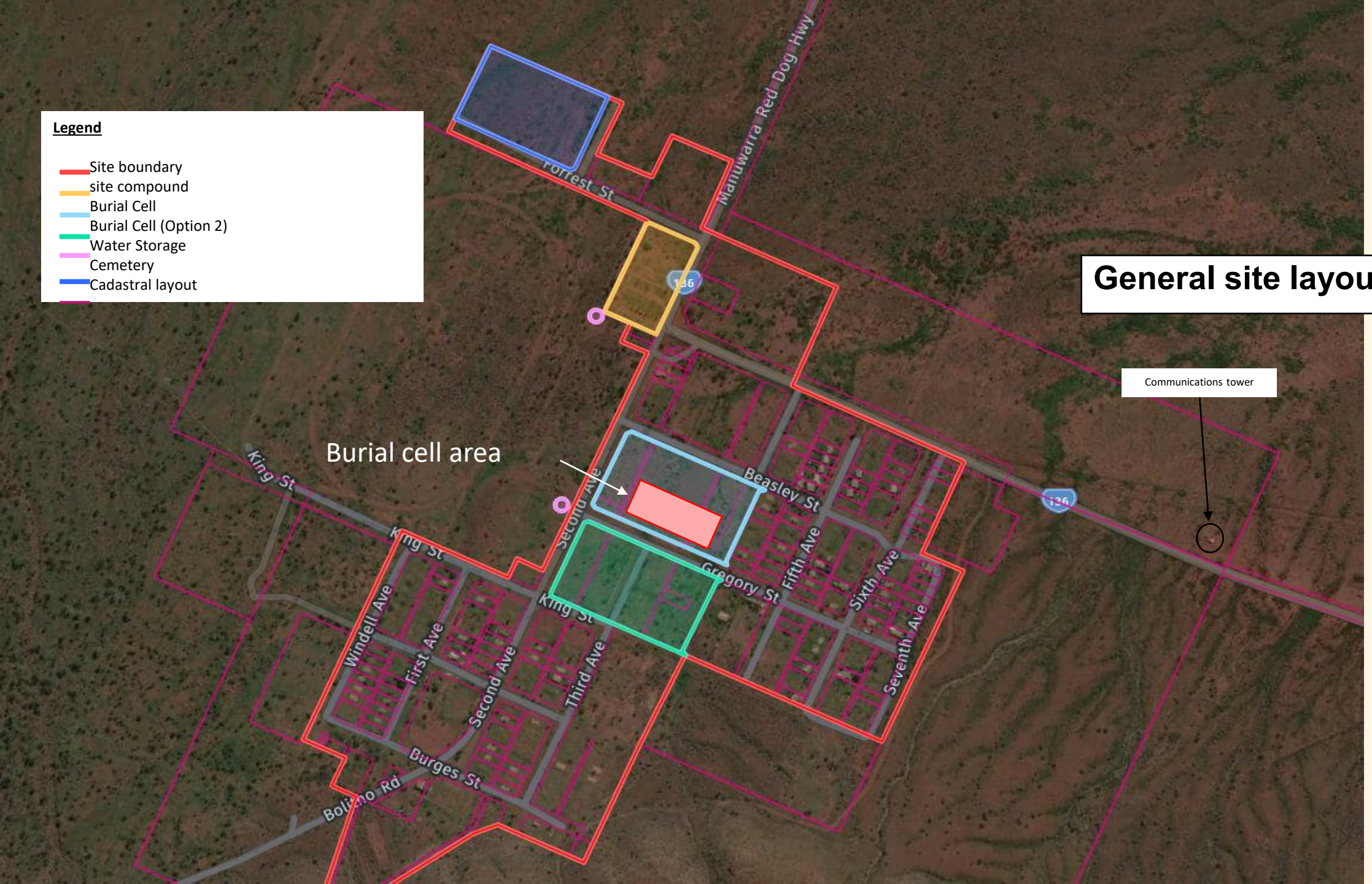
Project plan and overarching scope

- Demolish all remaining properties and infrastructure (excluding roadways) within the former townsite.
- Wittenoom Cemetery adjacent to the former townsite has a 50m exclusion zone for any disturbance works (there is a second cemetery out near the airport however that is far outside of the work area).
- Access restrictions in place as of April 4th.
- Physical barricades along Munjina Road and beyond, restricting vehicular access into Wittenoom townsite.
- Physical inspection of the gorge via both vehicle and aerial drone footage.
- Road blockade to the gorge and move on directions to any campers remaining. Sufficient signage and staff stationed at the gorge access road in the event that any vehicles were not identified.
- Demolition works scheduled to commence approximately April 20th.
- Contaminated materials to be buried in-situ into a large containment cell within the townsite.
- Dust management measures in place and all plant and equipment have HEPA filtration systems installed.
- Estimated completion date end of June 2023 (total 12 week program).

Project execution plan




Cultural awareness



General site layout

Barriers and road blockade points

Legend

- Site boundary
- Site compound
- Cemetery
- Barricading (1.2 km)
- Blockade of access road

Communications tower

136

136

Beasley St

Gregory St

Lockyer St

Burges St

Bolitho Rd

Waterways and road blockade points


Blockade to the town


Blockade to the gorge


DANGER
AREA CLOSED
ASBESTOS RISK


Site compound


HTZ9503


THU48


DECONTAMINATION UNIT
24 Hour Phone 1300 848 766
Thuroona Services
HAZRAD
CLEAN
DECONTAMINATION UNIT
THUS7
Thuroona Services
HAZRAD
coatesshire

Heavy vehicle decontamination


DANGER
DEMOLITION IN PROGRESS
WARNING
Government Worksite
Access through Townsite and Gorge Closed
No unauthorised entry
DANGER
ASBESTOS
STRICTLY NO ENTRY PAST THIS POINT
DANGER
ASBESTOS REMOVAL IN PROGRESS
DANGER
DEEP EXCAVATION
coateshire
coateshire

Signage

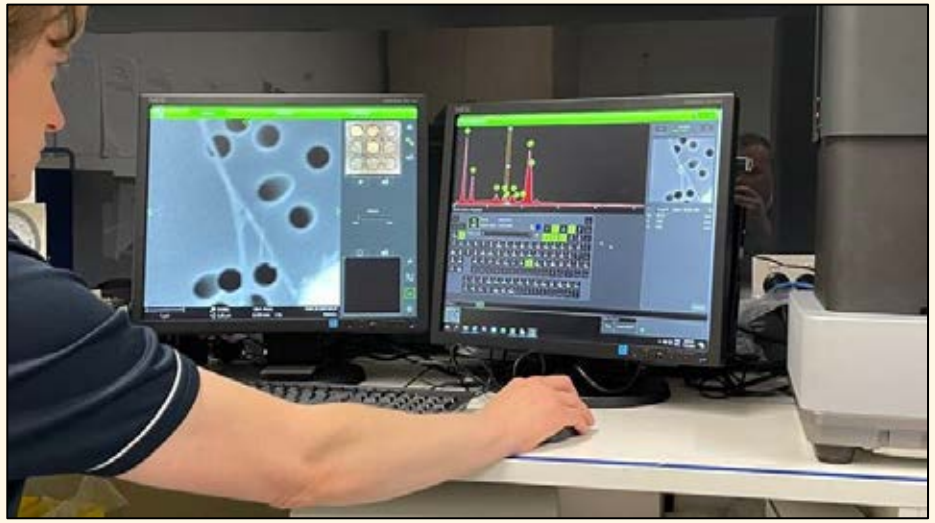
HEPA filtration systems / positive pressure units installed in plant and equipment (this is the highest level of protection available for workers in the industry)

HEPA cabin filtration units

Remote controlled filling of water cart


THU45
THU44
Thurpoona Services
HAZRAD

- Tetra Tech Coffey embedded for all occupational hygiene, monitoring (WHS requirements and study).
- Respirable dust monitoring stations - traditional and real-time.
- Airborne Fibre Monitoring (AFM) – traditional (per legislation) and novel, including SEM and Realtime.
- Benchtop Scanning Electron Microscope (SEM) – Only field-portable SEM for asbestos in Australia. Imported from Eindhoven (Netherlands) for this project, run by Tetra Tech. High-resolution chemically accurate results on-site, rather than transporting back to Perth, waiting 3-5 days for results.
- Selected samples sent for analysis at the only NATA-accredited equivalent laboratory in Australia.
- ActiveX – New “instant alert” technology being trialed. 5 x units imported from the UK specifically for this project. The supplier has previously received research funding from the Asbestos Safety and Eradication Authority (ASEA) - Australian Federal Government.
- This is the first time in Australia that this combination of technology was used.



Air monitoring


Date/Time: 24/5/2023, 11:03:22
Location: 22.30650°S 118.32404°E ± 5 m WGS84
Altitude: 511 m ± 4 m
Direction: 10 deg(T)
Address: Unavailable
Thuroona Services 1300 848 766

Dust suppression


Date/Time: 4/6/2023, 09:10:40
Location: 22.23991°S 118.33587°E ± 5 m WGS84
Altitude: 464 m ± 4 m
Direction: 135 deg(T)
Address: Unavailable
Thuroona Services 1300 848 766

Dust suppression and demolition activities

Demolition activities


mainline
HAZRAD
Thurgona
NON POTABLE WATER
TW051


HITACHI


mainline
20


Containment cell

Cemetery access

Poor road visibility

Ask question using Slido

Scan QR code using your mobile device
or
Go to slido.com and enter event code #SWM1

GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Panel discussion - Lung carcinogens in the workplace

- Tracey Bence, President, Australian Institute of Occupational Hygienists
- Dr Matthew Govorko, KNOW Workplace Cancer Coordinator, Cancer Council WA
- Sally North, Acting WorkSafe Commissioner
- Pierina Otness, Senior Toxicologist, Department of Health
- Professor Dino Pisaniello, School of Public Health, University of Adelaide

GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Closing remarks

Acting WorkSafe Commissioner
Sally North

GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia

SAFE WORK MONTH 2023

Forum concludes

Thank you for being part of

Breathe easy:
Occupational health and hygiene forum

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