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Control Measures for Occupational Health Risks Relevant to Civil Construction Work

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Construction Work Health and Safety Research @ RMIT

1. Purpose of this guide

This guide provides an overview of control measures for occupational health risks relevant to civil construction work. It gives an overview of the types of controls available for a variety of occupational health hazards, including:


Airborne hazards


Diesel engine exhaust


Noise


Heat


Hand-arm vibration


Whole body vibration

Ultraviolet radiation

The guide is intended to help people making decisions about how best to control occupational health risks in construction workplaces.

2. How to use this guide

Available risk control measures for each occupational health hazard are presented in accordance with the Hierarchy of Control (HoC). The HoC is based on the principle that making the work environment safer and healthier is more effective than trying to change the behaviour of workers. It arranges occupational health risk controls in order of their effectiveness.

The levels of the HoC are:

- **elimination:** this is the most effective form of control because the elimination of a hazard poses no risk to the worker or the public. For instance, building roofs at ground level can reduce the hazard of falling from height (If the hazard cannot be eliminated, can the hazard be substituted for something else?)
- **substitution:** this involves replacing the hazard with a less harmful alternative. For instance, there may be alternative glues or paints that reduce the need for ventilation or personal protective clothing (If the hazard cannot be substituted, can the hazard be reduced with an engineered control?)
- **engineering controls:** these isolate or separate people from hazards, such as using screens on high rise construction to remove the hazard of workers falling or tools and materials being dropped (If the hazard cannot be controlled through engineering, can the hazard be controlled or reduced through an administrative process?)
- **administrative controls:** these include measures designed to change the way workers undertake a task, for example developing safe work procedures or implementing a job rotation scheme to limit exposure, or providing training on specific hazards (If the hazard cannot be controlled through administrative means, can the hazard be controlled or reduced through the worker wearing protective equipment?)
- **personal protective equipment (PPE):** this is generally regarded as the least effective control measure as it relies on the individual to use it, such as dust masks, ear plugs or fall-protection harnesses. If such controls are not worn or worn properly, they are ineffective. Although, much emphasised and visible on a worksite, PPE should be seen as a "last resort"

The levels of controls can be categorised into three levels:

Level 1 controls are the most effective control measure and eliminate the hazard and the associated risk.

Level 2 controls minimise the remaining risk by substituting the hazard and/or isolating the hazard from workers. Isolation involves a physical separation of the hazard by barriers or distance.

Level 3 controls rely on human behaviour and do not control the hazard itself. As a result, level 3 control measures are less effective than level 1 or level 2 controls. They reduce the risk by using administrative controls, which include work methods and procedures that are designed to minimise the exposure, and/or the use of personal protective equipment. PPE reduces the exposure of the effects of a hazard. However, the effectiveness of level 3 controls, such as respiratory protection, is only effective if it is worn correctly[1].

In Australia, duty holders must prioritise to level 1 controls, followed by Level 2 controls, then and only where level 1 and 2 controls are not reasonably practicable, apply level 3 control(s).

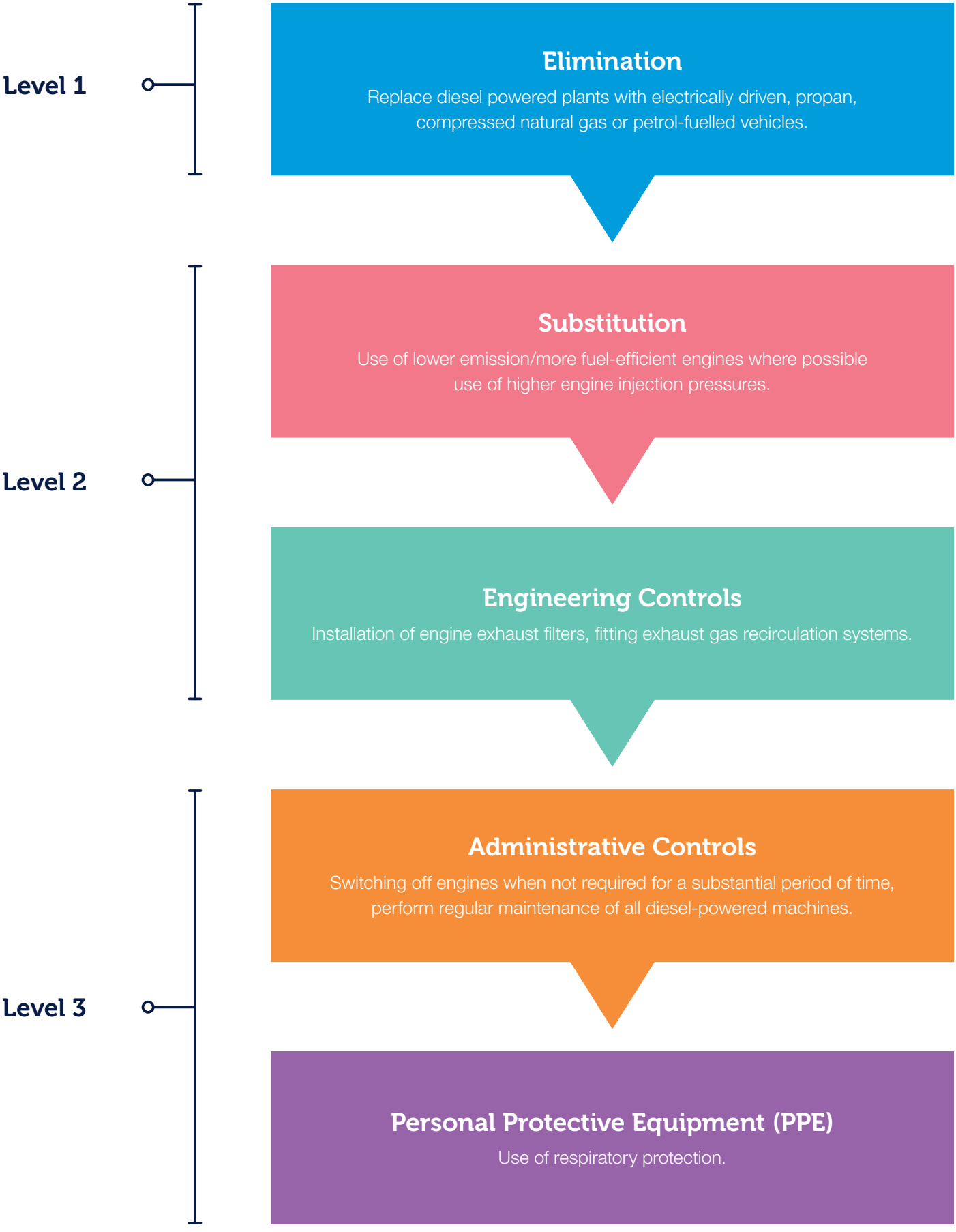
The HoC with a classification to the different levels is depicted in Figure 1 using controls for diesel engine exhaust.

In selecting methods to reduce the risk of occupational injuries or ill-health, decision-makers should first understand all of the available control methods that could be implemented and then start from the top of the hierarchy and work down, ensuring that they select the highest level of control measure that can be implemented.

The guide is not intended to be prescriptive. Appropriate risk controls should be selected based on a thorough assessment of the risks and circumstances of the workplace.

1 Safe Work Australia 2011, *How to Manage Work Health and Safety Risks*, retrieved on 27 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1702/how_to_manage_whs_risks.pdf

Figure 1: Hierarchy of control.



3. Background information

Construction activities involve a variety of serious occupational health risks. Among other construction tasks, construction workers face an array of health hazards in their work environment.

The most common disease-causing hazards construction workers experience at the workplace are airborne hazards, noise and vibration[2]. The prevalence of functional limitations and chronic diseases that are associated with these hazards increases over time and the associations with different health outcomes are well documented. For example, the prevalence of lung disease is significantly higher amongst construction workers compared to white-collar workers[3]. In addition, regular exposure to high noise levels can cause deafness[4]. Furthermore, in excess of 50% of the construction workers, especially trade workers and technicians, are exposed to hand-arm vibration[5] which is known to be associated with the hand-arm vibration syndrome.

As a result, construction workers have high rates of occupational illness. The Australian construction industry recorded an incident rate (serious claims per 1000 employees) of 0.9 for occupational diseases from 2015 to 2016. Even though the number of serious claims for occupational diseases declined from 2000 to 2015 by 15 per cent to 10,880 claims[6], the associated costs were $216,150 per incident[7]. This is almost three times higher than the cost of a work-related injury across all industries. This is also reflected by the time lost for claims involving occupational illness. The time lost increased from 6.8 weeks in 2000-2001 by 35 per cent to 9.2 weeks, in 2014-15. This is almost two times longer than the time lost for injury and musculoskeletal disorders[8].

The median compensation paid by nature of disease increased by 112% from 2000-2001 to 2014-2015. The total cost for the Australian economy for work-related diseases, was $33.7 billion in 2012-13[9], whereby the cost for the construction industry alone, was almost $3.0 million in 2012/13[10]. These numbers highlight the need to control occupational health hazards effectively.

Hierarchies of Control

Hierarchies of Control for each of the occupational health hazards are presented in the remainder of the guide. Decision-makers should start from the top of the hierarchy and work down, ensuring that they select the highest level of control that it is reasonably practicable to implement in their workplace.

2 Safe Work Australia 2015, Work, Health and Safety perceptions: Construction Industry, retrieved 26 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1702/whs-perceptions-construction-industry.pdf

3 Dong, X S, Wang, X, Daw, C Ringen, K 2011, Chronic diseases and functional limitations among older construction workers in the United States: A 10-year follow-up study, *Journal of Occupational and Environmental Medicine*, vol. 53 (4) pp. 372-380.

4 Health and Safety Executive 2006, Health and safety in construction, retrieved on 27 June 2018, www.hse.gov.uk/pUbns/priced/hsg150.pdf

5 Safe Work Australia 2015, Work, Health and Safety perceptions: Construction Industry, retrieved 26 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1702/whs-perceptions-construction-industry.pdf

6 Safe Work Australia 2017, Australian Workers' Compensation statistics, retrieved 27 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1801/awcs_2015-16_report-20171023_v3_0.pdf

7 Safe Work Australia 2015, The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012–13, retrieved 29 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf

8 Safe Work Australia 2017, Australian Workers' Compensation statistics, retrieved 27 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1801/awcs_2015-16_report-20171023_v3_0.pdf

9 Safe Work Australia 2017, Cost of Injury and illness by occupation, retrieved 29 June 2018, www.safeworkaustralia.gov.au/statistics-and-research/cost-injury-and-illness-occupation

10 Safe Work Australia 2015, The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community:2012–13, retrieved 29 June 2018, www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf

Airborne hazards

Elimination

— eliminate airborne hazards (however, this is often not possible especially when working with sand/concrete, or when undertaking tunnelling activities)

Substitution

— use garnet as a substitute for sand
— use aluminium oxide polishing powders instead of silica powders
— use pilled solids instead of powders
— use wet processes instead of dry processes
— vacuum instead of sweep

Engineering Controls

— use ventilation systems (local exhaust ventilation systems are available such as enclosing hoods, high velocity low volume hoods and exterior hoods)
— implement vacuum cleaners
— use water or fine mist suppression to control dust cloud (additional water dust suppression should be applied for tasks which are outside during dry weather or to control dust in mines)
— install a conveyor belt wash box where conveyor belts are in use
— implement dampeners to increase the air flow
— use sticky floor mats and barrier protections at the entrance to the working area to reduce the amount of filth transferred to any other working area
— provide fresh air by using controls like a canopy air curtain to cover roof bolters operators and enclosed cabin filtration systems
— for tasks where asbestos may occur the following additional controls should be considered:
  - implement barrier protections at the entrance to the working area
  - use sticky floor mats to reduce the amount of dust or debris transferred to other working areas
  - use thickened substances such as pastes and gels to cover the surfaces of asbestos being worked on
  - use shadow vacuuming

Administrative Controls

— maintain good housekeeping and signage
— restrict time of exposure
— do not perform dust-generating tasks, such as dry brush sweeping, and the use of compressed air or reuse of vacuum filters
— do not carry out dust-generating work on high wind days
— reduce the time spent in the dusty areas by job rotation
— train the workers how to use PPE correctly and which PPE is appropriate for the task
— inform workers about risk of exposures and instruct them how to protect themselves
— conduct health monitoring regularly
— for areas in which asbestos may occur:
  - forbid drinking, eating and smoking while working in areas where asbestos may occur
  - remove disposable shoe covers or overalls before leaving the working area (if covers aren't used, contaminated shoes and clothing should be cleaned before leaving)
  - provide washing facilities as close as possible to the working area including mild skin cleansers and clean soft paper or towels for drying
  - encourage workers to wash areas of their skin which might have been exposed and to use pre-work creams, if necessary, before starting work or after a break
  - avoid dust-generating activities on high wind days when working outdoors
  - remove construction debris through an approved route, if possible during off peak times (the debris should be covered and netted when removed)
  - conduct health monitoring including a physical examination of the worker with a focus on the respiratory system
  - conduct additional H&S training or awareness programs to increase workers understanding of the risk with a specific task, environment or material-related activity

Personal Protective Equipment (PPE)

— provide appropriate filters for workers (P1 filters are for mechanically generated particulates like silica or asbestos, P2 filters are for thermally and mechanically generated particulates like metal fumes, P3 requires a full face mask and can be used for all particulates including highly toxic materials like beryllium)
— provide coveralls, respiratory protective equipment, footwear and gloves in addition to other control measures, when working with asbestos
— provide hand protection creams
— use closed eye goggles for any kind of overhead or demolition work

Diesel engine exhaust emissions

Elimination

— replace diesel powered plants with electrically driven, propan, compressed natural gas or petrol fuelled vehicles

Substitution

— use lower diesel emission engines/cleaner fuels (e.g. low sulphur diesel) or more fuel-efficient engines

Engineering Controls

— install engine exhaust filters
— install a local tailpipe exhaust ventilation which attaches a hose to the tailpipe and connects the tailpipe to a fan
— install other ventilation techniques such as dilution ventilations or local extraction ventilation
— combine local extraction ventilation with other ventilation such as the tailpipe exhaust ventilation
— use other ventilation, such as exhaust gas recirculation, catalytic converters or selective non-catalytic reduction
— use diesel emissions 'after treatment' systems
— fit exhaust gas recirculation systems
— use enclosed cabins in vehicles with filtered air
— provide fresh air by using controls like a canopy air curtain to cover roof bolters operators (and enclosed cabin filtration systems)
— separate areas in which diesel engines are operating

Administrative Controls

— use processes or systems of work which reduce the generation of diesel engine exhaust emissions
— reduce the number of employees directly exposed and their period of exposure (e.g. through rotation or work schedules)
— prohibit/restrict unnecessary lugging or idling of engines
— restrict the total engine horsepower and number of diesel-powered equipment in defined areas
— allocate areas without any diesel engine operation and personnel travel
— set up speed limits and put one way traffic routes into place to reduce the level of traffic
— restrict the number of vehicles operating according to the capacity of the ventilation system
— perform regular maintenance of all diesel-powered machines and equipment
— perform annual training for workers
— perform routine cleaning or replacement of air filters, regular tuning of the engine
— monitor emissions and record backpressure on exhaust treatment devices at each routine service

Personal Protective Equipment (PPE)

— use of respiratory protection

Noise

Elimination

— avoid the usage of noisy machinery or processes, removing noisy operations away from other work activities

Substitution

— use alternative methods and equipment by replacing noisy equipment or machines with quieter ones where appropriate, for example:

- use rubber tyres instead of solid wheels
- use electrical engines instead of fuel engines
- use conveyor belts instead of rollers
- use electrical tools instead of pneumatic tools
- use plastic gears instead of metal gears
- use fibre bearings instead of metal bearings
- use slide bearing instead of rolling bearing
- use hammer drills instead of impact wrenches

— modify working methods or proceedings to reduce noise where appropriate, for example:

- weld instead of rivet
- evacuate instead of discharge
- use a kraft former machine instead of flange with a hammer
- use a laser cutting machine instead of a nibbling machine
- use optical signals instead of acoustic signals
- glue instead of hammer
- clip instead of staple
- grind instead of chip

Engineering Controls

— modify tools and machines to reduce noise, for example:

- add vibration isolation mountings, mufflers, laggings and silencers where possible to reduce noise
- provide wear-resistant rubber or plastic coatings to reduce acoustic sounds
- stiff/fix damping materials to panels or other surfaces to reduce noise impact of items during processing
- use acoustical silencers in intake and exhaust systems
- implement acoustical silencers in intake and exhaust systems

— use noise dampening mats to reduce heavy equipment noise

— add noise barriers and/or noise enclosures

— use a sound-reducing enclosure that fully covers the machine(s)

Administrative Controls

— replace worn bearings and or gears and maintain machines regularly

— maintain optimum speed of machinery or its particular components

— implement noise perimeter zones

— train workers in the correct use of personal hearing protectors and when to wear them

— schedule work according to the noise level

— conduct noisy work when there are minimal people on the worksite

— inform workers when noisy work will be carried out

— keep workers out of noisy areas especially if they do not have to be there as part of their job

— provide quiet areas for breaks

— restrict the time workers spend in noisy areas

— implement a job rotation scheme

— purchase new plant and equipment that produces less noise

— identify hearing protection zones and clearly sign-post noisy areas

— monitor workers to ensure they wear hearing protection

Personal Protective Equipment (PPE)

— provide personal hearing protectors of correct rating suitable for the work conditions

Heat

Elimination

— stop work

Substitution

— use automated equipment or processes to access hot locations (e.g. a drone to inspect a ground fire)
— schedule workers to work elsewhere, where possible
— install automated or remote-controlled machinery so that workers do not have to do physically demanding work by hand
— use plant or other equipment to reduce manual labour (e.g. a crane or forklift to lift heavy objects)
— substitute heat generating plant and equipment

Engineering Controls

— provide extra ventilation in enclosed workplaces which have the possibility of becoming hot
— modify ventilation, regulate air flow, provide extra fans for low air flow areas, refrigerate air/water supply
— include shelters to reduce heat gain
— implement shade structures to reduce surface heat exposure
— provide site sheds and facilities with air-conditioning

Administrative Controls

— rotate employees that work in hot areas
— provide drinking water for workers and guidelines for fluid intake under different conditions
— provide hygiene facilities
— establish a risk assessment system and schedule surveillance
— consider a personal heat risk assessment checklist for workers
— enable self-pacing
— implement regulations for work and rest according to the general health, body weight, level of physical fitness and (if any) medication taken by each worker
— organise work to minimise physically demanding tasks (e.g conduct work at ground level to minimise climbing up and down stairs or ladders)
— modify targets and work rates to make the work easier and reduce physical exertion
— ensure workers are not working alone, or if they must work alone, monitor them and make sure that they can easily call for help
— implement mandatory breaks, consider an assessment of worker's hydration levels
— provide workers with information and training about the risks and symptoms of heat stress
— introduce a hydration program

Personal Protective Equipment (PPE)

— provide cooling vests (with gel or circulating liquids) and shade hats
— modify uniforms or required dress codes so workers can wear cooler, more breathable clothing

Hand-arm vibration

Elimination

— automate or mechanise the work where appropriate

— use alternative methods if it is technically appropriate (e.g. a breaker attachment on an excavating machine to break concrete instead of a hand-held breaker)

Substitution

— change work methods where appropriate (e.g. use a diamond-hole cutting drill with rotary action instead of a tungsten-tipped hole bit to reduce the exposure time)

— use alternative equipment which reduces the duration of the vibration. Instead of using hand-held hammers and/or breakers, where possible, use:

- machine-mounted hydraulic breakers
- floor saws
- directional drilling/pipe jacking to avoid trenching
- hydraulic crushers
- hydraulic bursters
- diamond core drilling
- diamond wire cutting

— use equipment and consumables which claim to reduce vibration such as saw blades or ceramic abrasives

— design workstations in a way that they minimise loads on workers hands, wrists and/or arms

Engineering Controls

— use vibration reducing devices:

- anti-vibration side handle
- comfort grips
- tensioners/spring balances
- resilient coatings
- grinding wheel balancers
- rear handle bushing
- drilling rigs
- saw clamping system
- elephant trunk suspension system
- vibration reducing flange or two chisel sleeves

— use alternatives (chemical or hydraulic breaking methods) to crop pile caps instead of hand-held hammers/ pneumatic breakers

— avoid unnecessary drilling and if possible:

- use jig-mounted drilling or diamond core drilling
- cast-in anchors and channels for wall fixings instead of drill-and-fix types
- direct fastening tools instead of electric hammer drills

— provide suspension seats

Administrative Controls

— limit the use of high-vibration tools

— plan work with several shorter periods instead of long ones

— provide training for the purchasing staff to purchase equipment and consumables which reduce vibration levels

— provide training on how equipment can be used to minimise vibration

— provide training on the risks of vibration

— maintain all devices and equipment regularly to prevent an increase of vibration

— use correct equipment (not damaged) and replace old equipment

— limit or reduce the time that workers are exposed to vibration by job rotation and shorter duration being exposed to vibration

— arrange regular breaks for workers who are exposed to vibration

— encourage the workers/operators to exercise their fingers

Personal Protective Equipment (PPE)

— provide clothing which encourages blood circulation

Whole-body vibration (WBV)

Elimination

— introduce remotely controlled mobile plant rather than plant driven by workers

Substitution

— purchase or hire mobile plant, which has lower vibration emissions or is more suited to the task

— isolate or dampen a work platform to eliminate or minimise vibration from a motor using rubber mounts and a flexible connection

Engineering Controls

— insulate seats and head rests through incorporation of spring and dampers

— provide vehicles with suspension seats and include seat springing

— select tyre types according to the terrain

— check suspension, roadways and tyres regularly

— smooth uneven surfaces on construction sites

Administrative Controls

— limit the speed at which vehicles travel depending on terrain conditions

— introduce a roster system to minimise the duration each worker is exposed to WBV

— incorporate mini breaks on a regular basis

— incorporate seat maintenance and replacement programs

— maintain roads and other surfaces in good condition if reasonably practicable

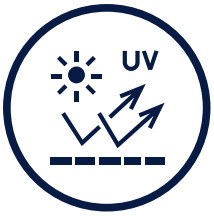
— provide training to workers about the risks of vibration (including information about the sources of WBV and how the vibration can be minimised as well as how to recognise and report symptoms)

— maintain all equipment in cyclic periods

Personal Protective Equipment (PPE)

— workers standing on a vibrating platform can wear shoes that have soles designed to minimise the effect of vibration to their feet

— provide clothing which encourages blood circulation



Ultraviolet radiation (UV)

Elimination

— carry out the work indoors in the case of UV from the sun

Substitution

— move work to existing shade at the worksite, such as shade from trees and/or buildings

— change or avoid reflective surfaces to reduce reflective UVR

Engineering Controls

— install shade structures over (outdoor) work sites and rest areas, such as portable sun shades

— apply tinted or clear films to the side windows of vehicles to reduce the amount of UVR exposure

— consider engineering controls, such as door interlocking power supplies, UVR blocking filters or opaque barriers in case the UVR exposure is from a non-solar source (e.g. welding)

Personal Protective Equipment (PPE)

— provide PPE :

- sun protective hats
- sunglasses
- sun protective work clothing
- sunscreen
- lip balm

— consider providing fabric patches in protective clothing and workwear which indicates when the protective performance of clothing has been degraded

Administrative Controls

— conduct a risk assessment (identify workers who have a high risk of exposure and also situations in which high exposure occurs)

— carry out outdoor work in the early morning and/or late afternoon when the level of ultraviolet radiation is lower, if possible

— schedule indoor or shaded work tasks when levels of UV are strongest

— rotate the workers to reduce the time exposed to the sun and increase the number of workers to reduce the individual exposure time

— vary the tasks to reduce the exposure time

— encourage workers to switch/rotate between outdoor, indoor and shaded work tasks with the aim to reduce the exposure time

— provide shaded outdoor or indoor areas for breaks

— increase lengths and duration of breaks

— provide daily information about the UV Index and encourage workers to use an UV alert on their smartphones

— provide health check-ups/health surveillance (e.g. regular skin and eye checks for the exposed workers)

— inform/train workers (how) to work safely in the sun (it should also include a correct application and usage of personal protective equipment)

— educate workers how to examine their skin effectively

— implement sun protection practices during work related events

— promote the use of sun protection practises after work and on the weekends

— ensure supervisors, managers and foremen act as positive role models

— inform workers about the harmful effects of UV exposure and the risks on the worksite

— consider implementing wearable UVR trackers to monitor exposure (and to provide readings and warnings when dangerous levels of UVR exposure are reached)

— include warning signs if the UVR exposure is from a non-solar source (e.g. welding)

— instruct workers to keep a safe distance from the UVR source

— monitor and review control measures

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"On average over 250 workers in Australia die from an injury sustained at work each year. It is estimated that over 2000 workers die from a work-related illness each year[11]. "

"Asbestos-related diseases kill more people than any other single work-related cause[12]."

"Approximately 587,000 Australian workers were exposed to silica dust in the workplace in 2011. It has been estimated that 5758 of these will develop a lung cancer over the course of their life as a result of that exposure[13]."

"In 2012–13, work-related injury and disease cost the Australian economy $61.8 billion[14]."

11 Safe Work Australia 2012, Australian Work Health and Safety Strategy 2012 – 2022, p. 1, retrieved on 27 April 2018, www.safeworkaustralia.gov.au/system/files/documents/1804/australian-work-health-safety-strategy-2012-2022v2_1.pdf

12 Health and Safety Executive 2006 Health and safety in construction, p. 86, retrieved on 27 June 2018, www.hse.gov.uk/pUbns/priced/hsg150.pdf

13 Cancer Council Australia 2017, Silica dust, retrieved on 18 July 2018 , www.cancer.org.au/preventing-cancer/workplace-cancer/silica-dust.html

14 Safe Work Australia (2017), Cost of injury and illness by occupation, retrieved on 28 June 2018, www.safeworkaustralia.gov.au/statistics-and-research/cost-injury-and-illness-occupation