Breathesafe

16 November 2016

Dear Research Director,

CWP select committee

Parliament House

George Street

Brisbane QLD 4000

Submission to Queensland Parliamentary for The Coal Workers' Pneumoconiosis CWP select committee.

Via email: cwpsc@parliament.qld.au

Please find enclosed written submission regarding the inquiry into Coal workers' Pneumoconiosis select committee.

Terms of reference of engineering measures, practices, monitoring and prevention.

Since there has been a recent confirmed case of CWP with an open cut machine operator we urge the select committee to include processes where personnel are subject to extended exposure levels to coal dust and other airborne hazards.

Your Sincerely,

Nick Johnstone

Director

Breathe Safe Pty Ltd

290 Beatty Road

Archerfield QLD 4108

Summary

In response to the CWP enquiry:

Breathe Safe's aim is to promote continuous improvement in engineering controls as part of the risk management systems within the industry.

CWP is caused by exposure to coal dust, Prevention, in this context, means limiting exposure.

CWP will be prevented from compliance with new regulatory standards and proper engagement of engineering control measures, administrative control measures and training for workers in order to evaluate their own safety.

The coal industry, government departments, operators and mine personnel need to contribute and collectively work to identify high risk areas and to reduce prolonged exposure to coal dust and other harmful nanoparticles associated with lung disease.

Technology in the field of pressurised enclosed operator cabins can significantly reduce risks to machine operators.

1. Introduction

Australia will remain a lead producer and exporter of coal. The 2015 annual report by BP placed Australia as the 4$^{th}$ largest net exporter of coal. [1] Due to the nature of and properties of carbon - Coal dust contains complex contaminants such as silica, iron, cadmium and lead. Airborne particles have a significant impact in the risk of developing pneumoconiosis. [2]

The processes of exploration, handling and transportation are potentially harmful. It is submitted that the committee also include and consider aspects of all surface coal machine operators. Given that there may be further cases of CWP amongst personnel that are subject to continuous exposure to coal dust and other harmful coal dust particles and others in the nanoparticle range.

The NIOSH Coal Workers Health Surveillance 2010-2011 study examined 2000 surface coal miners in 16 US states. The data has shown a greater risk when there is long term exposure – 2% of miners with greater than one year of surface mining experience developed CWP. It also, found that 0.5% of these miners had Pulmonary Massive Fibrosis. [3]

The resurgence in lung disease is the result of many factors. Including excessive exposure to coal mine dust levels, duration caused by longer shifts, and the current methods of mining and handling coal. [4]

Additionally, there may be no safe level to prolonged exposure to coal dust and to nanoparticles and further research in this area is supported. [5]

Since there is no legislation regarding enclosed operators cabins on fixed and mobile plant. It is thought that mine sites may be unaware as to the proper engineering controls and measures to deliver a clean working environment.

An enclosed air conditioned cabin without a system to filter out contaminants and to add positive pressurisation may in fact result in a worse outcome for the operator. As the air, inside may become highly contaminated by the HVAC system design to continuously recycle the air inside.

| Particle size | Fall Velocity [cm/s] | Duration of fall from a height of 1 m [min] |
|---|---|---|
| 0.1 micron | 0.00006 | 500 hrs |
| 1 micron | 0.006 | 5 hrs |
| 10microns | 0.6 | 3 mins |
| 50 microns | 15 | 6 s |

Floating behaviour of dust particles (density *2 g/cm³* ) in air. Coal dust particle size is 1 to 100 microns [6]

It should be noted that Queensland's coal dust limit is 3mg/$m^3$ air – higher than that of NSW and the US. It is submitted that it should be at least equal to, or less than these counterparts.

The recent report of The Select Committee on Health relating to black lung submit coal mining companies adopt the lowest Australian level of 2.5mg/$m^3$ until a national standard has been agreed upon and implemented. [7]

2.Innovation

Breathe Safe is locally designing and manufacturing cabin pressurisation systems for use with enclosed operator cabins in the mining industry, quarry, foundry and agricultural sector.

Breathe Safe is committed to working with OEM manufactures and end users to deliver systems capable of delivering high quality air.

Surveys in the US have shown that pressurised system with filters in an enclosed cabin can effectively control the operator's dust exposure. [8]

The technology exists where an enclosed pressurised cabin can be remotely monitored for positive pressure and equipped with a digital display and visual warning to alert the operator if the pressure has fallen below the required level.

Data logging functions to demonstrate that over time positive pressure has remained are already part of these systems.

3.Other jurisdictions (legislation and best practice).

The UK prevalence of CWP has decreased and it is now lower than in previous decades. This reflects an overall reduction in exposure to coal dust. However, data is affected by a substantial reduction in the size of the coal industry since the 1980s. [9]

Best practice guides are available for workers operating in enclosed cabins for which these may be useful to educate and advise of minimum requirements, for example: The HSE UK provides a best practice guide for (Silica) Quarry operations: [10]

***QY11: Control cabins with forced filtration***
*✓Consult a qualified ventilation engineer to assure that the design will cope with the anticipated dust levels. The design should cover the following points:*
*■ pre-filters, to protect the main filter if coarse silica dusts are present;*
*■ HEPA filters (BSEN 1822):*
*– type H11 for external RCS concentrations below 1 mg/m3;*
*– type H12 or H13 for external RCS concentrations above 1 mg/m3;*
*■ pressure gauges to show the system is working properly;*
*■ alarms to sound when filters clog;*
*■ overpressure around 10 Pa inside the cabin to prevent dusty air ingress;*
*■ flaps to release excess pressure;*
*■ door seals - heavy-duty neoprene or other suitable material; and*
*■ self-closing doors.*

Using control cabins
✓ Abrasive dusts can wear out equipment quickly. Plan regular checks and maintenance of the critical parts.

✓ Check that the clean air supply is turned on and working at the start of work
✓ Check pre-filters regularly - keep spares
✓ Check integrity of filter seals daily if they are accessible. If they are not, check monthly and carry out a smoke test at the mid-point of the month.

***Vehicle cabs with forced filtration***
*✓High dust levels result from transferring material to the vehicle and haulage on unmade roads in dry weather.*
*✓Can you time mineral extraction for the wetter seasons?*
*✓Wash down metalled roadways regularly and limit vehicle speed.*
*✓The cab should have the following features:*
*■ pre-filter to protect the main HEPA filter;*
*■ pressure gauge to show the system is working properly;*
*■ overpressure around 10 Pa inside the cab to prevent dusty air ingress; and*
*■ door and window seals - heavy-duty neoprene or other suitable material.*

Using cabs with filtered air
*✓Abrasive dusts can wear out equipment quickly. Plan regular checks and maintenance of the critical parts.*
*✓Check that the control cab clean air supply is turned on and working at* the start of work.
*✓Check pre-filters regularly - keep spares.*
*✓Change inlet air HEPA filters as advised by the manufacturer, but at least after every 250 hours' use.*
*✓Keep doors and windows closed.*
*✓Check any air conditioning self-test every time the machine is started.*
*✓Vacuum clean the vehicle cab at least once a week. Use a Type H vacuum cleaner fitted with a HEPA filter.*

***Caution: Don't clean up with a brush or with compressed air.***

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3.1 Another industry in the European Union that has been moving forward is the agricultural sector which has implemented regulations regarding pressurisation for tractor cabins with a class system.

This industry standard is useful to mitigate exposure to gases and other factors that a machine will operate in.

DIN EN15695 [11]

| ENCLOSED CABIN CLASS | PROTECTION AGAINST | | MINIMUM REQUIREMENT | |
|---|---|---|---|---|
| CATEGORY 1 | DUST | NO | FRESH AIR FLOW | NOT REQUIRED |
| | AEROSOL | NO | PRESSURISATION | NOT REQUIRED |
| | VAPOURS | NO | PRESSURE INDICATOR | NOT REQUIRED |
| CATEGORY 2 | DUST | YES | FRESH AIR FLOW | 30 m³/h |
| | AEROSOL | NO | PRESSURISATION | 20 Pa |
| | VAPOURS | NO | PRESSURE INDICATOR | OPTIONAL |
| CATEGORY 3 | DUST | YES | FRESH AIR FLOW | 30 m³/h |
| | AEROSOL | YES | PRESSURISATION | 20 Pa |
| | VAPOURS | NO | PRESSURE INDICATOR | MANDATORY |
| CATEGORY 4 | DUST | YES | FRESH AIR FLOW | 30 m³/h |
| | AEROSOL | YES | PRESSURISATION | 20 Pa |
| | VAPOURS | YES | PRESSURE INDICATOR | MANDATORY |

3.3 NSW/ Draft Mining Design Guideline MDG15

The draft in NSW legislation outlines updated good practice to EU standard ISO 10263 which refers to operator enclosure cabin environment. It requires to expand and add pressure display and visual warning to alert the operator of any falling pressure and be capable of recording data.

*NSW/ Draft Mining Design Guideline / MDG15*

*3.15.5 Heating, demisting and fresh air supply*

*Heating, demisting and fresh air supply should be provided as follows:*

- *be capable to adequately demisting the operator's cabin window*
- *supply filtered external makeup air sufficient to maintain a positive pressure inside the operator's cabin with windows and doors closed*
- *the air supply system should make adequate allowance for deterioration of door and window seals*
- *the heater should have isolating valves fitted to both supply and return lines adjacent to engine too allow changing of heater hosed and/or core without disturbance to the cooling system*

*Guidance to operator enclosure environment is given in ISO 10263 1 to 6.*

The table below demonstrates dust control methods and effectiveness: [12]

| DUST CONTROL METHOD | EFFECTIVENESS (Low is 10%-30%, moderate is 30%-50%, high is 50%-75%) | *COST AND DRAWBACKS* |
|---|---|---|
| Dilution ventilation | Moderate | High – more air may not be feasible |
| Displacement ventilation, including enclosure with extraction of dusty air | Moderate to high | Moderate – can be difficult to implement well |
| Wetting by sprays | Moderate | Low – too much water can be a problem |
| Airborne capture by sprays | Low | Low – too much water can be a problem |
| Airborne capture by high pressure sprays | Moderate | Moderate – can only be used in enclosed spaces |
| Foam | Moderate | High |
| Wetting agents | Zero to low | Moderate |
| Dust collectors | Moderate to high | Moderate to high – possible noise problems |
| Reducing generated dust | Low to moderate | Moderate |
| Enclosure with sprays | Low to moderate | Moderate |
| Dust avoidance | Moderate | Low to moderate |

4. Review and strategies for administrative controls related to dusts

Successful hazard prevention – Measures and actions should not be imposed, but be discussed, by active participation from all concerned.

A decision-making ladder can be used:

1. Be aware of the problem
2. Accept there is a problem
3. Know/ find the cause
4. Learn of/ develop a solution
5. Accept solution
6. Know supplier (of solution)
7. Finance
8. Implement measures
9. Evaluate

Continuous improvement

Risk management system may be a complex matter. It must remain adaptable to needs and any technological changes.

It is most important to review and reassess the whole system and adjust for systems to be relevant.

The same approach applies in participation of the workforce. Teamwork is essential.

To ensure job satisfaction and realize continuous improvement, a suitable system for the recognition of achievements and failures is desired. Failures must be reviewed critically, not with the objective of “finding the guilty” but of pinpointing possible sources of errors to correct and avoid them. Achievements must be given ample credit and celebrated. It is important to use “positive reinforcement” by which more value is placed on achievements than on failures. [13]

References

[1] 2015 BP Statistical Review of World Energy – BP Global [xls], accessed November 2016 www.bp.com/.../bp/.../energy.../statistical-review-2015/bp-statistical-revie...

[2] Huang X, Li W, Mapping and prediction of coal workers' pneumoconiosis with bioavailable iron content in the bituminous coal. Environ Health Perspect. 2005; 113:964-968. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1280334/

[3] Morbidity and Mortality Weekly Report: Pneumoconiosis and Advanced Occupational Lung Disease Among Surface Coal Miners – 16 states 2010-2011 / Weekly. June 15, 2012 / 61(23);431-434. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6123a2.htm

[4] Coal Mine Dust Exposures and Associated Health Outcomes, A Review of Information Published Since 1995 [April 2011] accessed November 2016 https://www.cdc.gov/niosh/docs/2011-172/pdfs/2011-172.pdf

[5] Masige S, Safe coal dust exposure levels don't exist: study, accessed 29 September 2016 https://www.australianmining.com.au/news/safe-coal-dust-exposure-levels-dont-exist-study/

[6] Guldner K, Beschorner F, Silica – Ten golden rules for dust control 07/05/10 pdf, accessed November 2016 http://www.nepsi.eu

[7] Black lung review committee to submit interim findings today (2016, March 31) accessed November 2016, https://www.australianmining.com.au/.../black-lung-review-committee-to

[8] Organiscak J.A., Page S.J. Field assessment of control techniques and long term dust variability for surface coal mine rock drills and bulldozers, accessed November 2016 http://www.cdc.gov/niosh/mining/works/coversheet1178.html

[9] Darnton A, Silicosis and coal workers pneumoconiosis 2016, accessed November 2016, http://www.hse.gov.uk/statistics/causdis/pneumoconiosis/

[10] COSHH essentials in quarry: Silica QY11 HSE, accessed November 2016, http://www.hse.gov.uk/coshh/essentials/Qy11

[11] Agriculture DIN EN 15695 table for cab classes, accessed November 2015, http://www.rt-filter.de/en/kompetenz/kabinenluftfiltration/agrar-din-en-15695.html

[12] Kissell F, Handbook for Dust Control in Mining June 2003. Summary, accessed November 2016 http://www.cdc.gov/niosh

[13] Hazard prevention and control in the work environment: Airborne dust (WHO, 1999) 43-44, accessed November 2016, http://www.who.int/occupational_health/publications/airdust/en/

This submission is made on behalf of Breathesafe, an organisation committed to the protection of operators against respirable particles in enclosed cabins in the course of their employment.

This submission will address the following:

- What are respirable particles?
- How do they impact on health?
- Current legislative obligations
- Currently installed OEM systems
- HEPA Definition and efficiency
- How do Breathsafe equipment minimise illness
- Recommendations for legislative protection
- Conclusion

**What are respirable particles**

*"Dust: small solid particles, conventionally taken as those particles below 75 µm in diameter, which settle out under their own weight but which may remain suspended for some time".* ISO 4225:1994 Air quality (definition).

*"Dust: Small, dry, solid particles projected into the air by natural forces, such as wind, volcanic eruption, and by mechanical or man-made processes such as crushing, grinding, milling, drilling, demolition, shovelling, conveying, screening, bagging, and sweeping. Dust particles are usually in the size range from about 1 to 100 µm in diameter, and they settle slowly under the influence of gravity."* "Glossary of Atmospheric Chemistry Terms" (IUPAC, 1990),

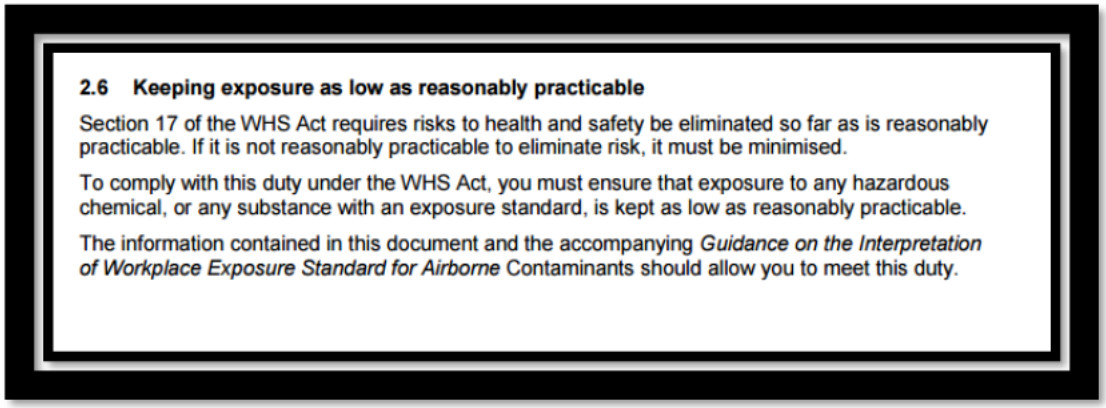
**How do they impact on health?**

Breathe-Safe's aim is Zero Harm. In preventing future cases of CWP and other related disease there must be a baseline protocol for the characteristics of an enclosed operator cabin in mineral processing sites where it is necessary to provide a safe working environment. It has been discussed extensively that occupational exposure to respirable particles is linked to higher health risks of all workers at mineral processing sites. Any risk associated with respirable particles must be moderated to practically Zero specifically when the operator is in an enclosed cabin. (See appendix C picture 1. Difference of nasal and oral breathing for dust inhaled and deposited in different regions of the respiratory airways).

An enclosed cabin must have a method of isolation to eliminate respirable particles and deliver clean air at the breathing zone of the operator.

**Current Legislative obligations**

A clear thoughtful process must be implemented to limit exposure by practicable means in accordance with the following guideline taken from Workplace Exposure Standards for Airborne contaminant by Work Safe Australia (ALARP) from the WHS Act 2011 where clear direction is given to limit respirable dust.



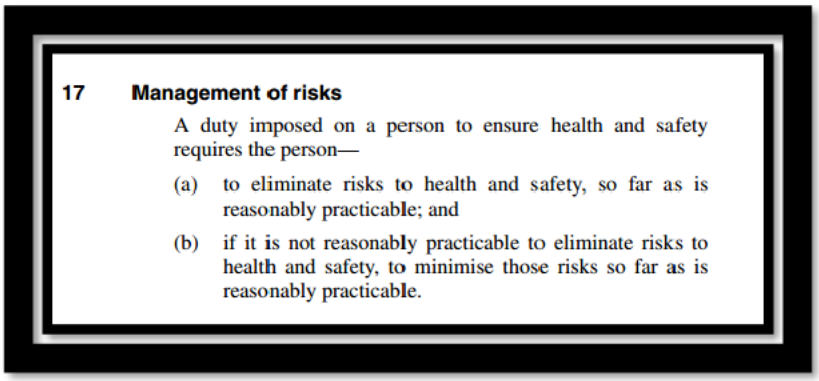
**2.6 Keeping exposure as low as reasonably practicable**

Section 17 of the WHS Act requires risks to health and safety be eliminated so far as is reasonably practicable. If it is not reasonably practicable to eliminate risk, it must be minimised.

To comply with this duty under the WHS Act, you must ensure that exposure to any hazardous chemical, or any substance with an exposure standard, is kept as low as reasonably practicable.

The information contained in this document and the accompanying *Guidance on the Interpretation of Workplace Exposure Standard for Airborne* Contaminants should allow you to meet this duty.

[1]



**17 Management of risks**

A duty imposed on a person to ensure health and safety requires the person—

(a) to eliminate risks to health and safety, so far as is reasonably practicable; and

(b) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable.

[2]

In November 2009, the EU enacted EN15695 standard for hazardous environment with the use an enclosed cabin for tractor operators spraying pesticides.

The standard is legislated to classify and to tests tractor cabins and it is expected that the same standard will eventually carry over to the construction sector.

Performance of enclosed cabins the standard implies the following:

- Pressurised system (air conditioned)
- Sealed enclosure is to maintain pre-set pressure (minimum 20 pascals)
- Pressure display (operator is aware of system working or service required)
- Tight against particulate
- Tight against gases and vapours

[1] Safe Work Australia, Workplace Exposure Standards for Airborne Contaminants, Apr.2013

[2] Work Health and Safety Act 2011. Effective 14 October 2016

EN15695 outlines four categories

*Category 1.* There is no level of protection against hazardous substances.

*Category 2.* Protection against dust.

*Category 3.* Protection against dust and aerosol.

*Category 4.* Protection against dust, aerosols and vapour (See Appendix C picture 2. Breathe-Safe complying system – HEPA & activated carbon media).

Category 3 and 4 are relevant in this instance in which both target particulate matter at the submicron level.

Vapour - The gaseous state of a substance that is solid or liquid at room temperature and pressure.

Aerosol - Particles (solid or liquid) that remain suspended in air for a period of time. Aerosols include mists, smokes, fumes, and dusts. (CCOHS-Glossary of Common Terms).

## Currently installed OEM systems

The commonly used ISO 10263:2009 1 to 4 International standards which designates testing and design for operator enclosure environment only goes as far as filtered fresh air and is capable of maintaining positive pressure but it does not comply with any testing of respirable size particles and ongoing testing. (See appendix E for an example of ISO 10263 in mining equipment. Draft rule NSW - MDG 15).

| ISO COARSE TEST DUST | | ISO FINE TEST DUST | |
|---|---|---|---|
| Particle Size in Micrometers (Microns) | Percent by Volume (+/- 3%) | Particle Size in Micrometers (Microns) | Percent by Volume (+/- 3%) |
| 001 – 005 | 10.5% | 01 – 05 | 36.0% |
| 005 – 010 | 11.5% | 05 – 10 | 18.0% |
| 010 – 020 | 14.0% | 10 – 20 | 20.0% |
| 020 – 040 | 25.0% | 20 – 40 | 17.0% |
| 040 – 120 | 37.0% | 40 – 120 | 09.0% |
| 120 – 180 | 02.0% | | |

The testing is compliant with ISO 5011 which is a test with fixed air protocol and tested with coarse and fine particles with the filter in a test chamber and it is not intended to achieve a filtration number. Furthermore, the test is designed for engine air cleaners.

The result is these filters can separate coarse particles but are **completely ineffective** in controlling respirable particles.

We submit that an OEM pressurised filtration systems in comparison will not comply with EN15695 due to filter inefficiency. (See appendix D for comparison of HVAC internal components using OEM filter and HEPA filter media).

In appendix A, we demonstrate that a standard OEM filter is not effective at removing respirable particles.

Picture 1. Is our baseline showing respirable practical concentration in the test area.

Picture 2. Is the test of OEM pressuriser using a standard combustion engine type filter in the same environment and evidently shows no reduction in concentration of respirable particles.

Picture 3. Is the same test but filtering through a HEPA filter tested as per EN1822 showing respirable particle count at practically zero.

## HEPA Definition and Efficiency

A true HEPA filter must comply with European Standard EN1822 testing.
This standard relates to efficiency requiring HEPA filters to remove 99.97% of all airborne contaminants at the 0.3-micron size range. Particles with a diameter of 0.3 in micron size are classified as the most penetrating particle (MPPS) due to its behaviour and it is the benchmark when complying with strict standards. (See Appendix B for HEPA diagram).

In summary:

- Both diffusion and interception are not as effective within this particle size.
- In testing, if 10000 particles at 0.3 microns are introduced then only 3 max can get through.
- Particles around 0.3 micrometres are most difficult to capture
- Particles lesser than 0.1 micrometres are trapped due to diffusion (random motion).
- Particles greater than 0.6 micrometres are captured by interception and impaction (direction and speed).

## Filter testing standard: EN1822

- EN1822 is the European test standard for HEPA / ULPA filters
- Certifies a filters' absolute minimum efficiency
- Used to certify air filters for clean room applications
- The two part EN1822 test identifies the MPPS and tests the filter with only these particles, creating a worst-case scenario (Schroth and Caesar 2001). [1]
- Individually certified filters

[1] TSI particle seminar 2008 – Krinke T & Horn H-G Test of filer media per EN1822

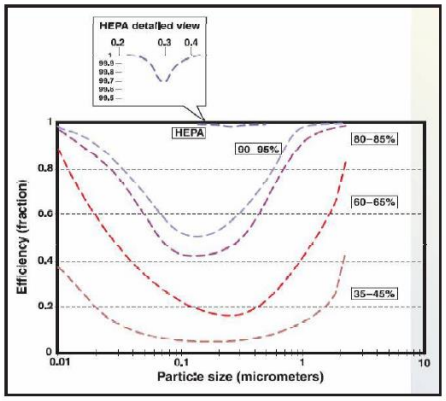



Figure 2 - Detail of HEPA Filtration Efficiency Versus Particle Size

Source: Donaldson HEPA filter chart. (Aerospace & Defence group).

## How does Breathesafe Equipment minimise illness?

NIOSH US studies found that with an enclosed pressurised system, when cabin door is briefly opened, the level of dust pollution concentration increased by 9-fold. Even while the operator stopped drilling and waited for visible dust to disperse. [1]

Additionally, tests were carried out with recirculation filters fitted and then with the recirculation filters removed in order to demonstrate decay time or the time required for the internal cab concentration to stabilise and to return to the prior levels of protection factor: the results were as follows

- Decay period without recirculation filter: 16 to 29 minutes.
- Decay period with recirculation filter: 6 to 11 minutes.

The protection factors in the study ranged from 3 to 89 respectively in a cab without pressurisation on one end and an optimised cabin with pressuriser and environmental sealing at the other.

The pressurisation level requirement is a minimum of 20 pascals with the pressure display needing to be as per EN15695-1 (Euro standard) and 50 Pascals without the pressure display also noting other NIOSH studies: (Note the higher protection factor from lower overpressure). [2]

[1] Cecala A.B, Organiscak J.A, Key components for an effective filtration and pressurization system for mobile equipment. Mining Engineering,2014 vol66, No.1. 44-50

[2] Cecala A.B, Organiscak J.A, Maximising Air Quality Inside Enclosed Cabs with Uni-Directional Filtration and Pressurisation System. https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/maqie.pdf

- Protection factor 56 with range between 50 – 100 Pascals
- Protection factor 89 with range between 17 – 30 pascals

In summary, the principal three factors are:

1. Pressurisation – An optimised system is required with the correct volume of fresh air and filter media to suit the application (HEPA for respirable particles).
2. The operator cabin must to be environmentally sealed to achieve effective pressurisation and thus achieve a protection factor
3. A pressure display must be present to let operator know that system is working correctly

(Note: Higher overpressure systems will deform seals quickly which will require continuous maintenance).

## Recommendations for legislative protection

These are Breathe-Safe's recommendations to provide the best possible working environment for the operators of mobile & fixed plant with the following components in a qualifying enclosure:

- Cabin Pressuriser with cabin sealing capable of maintaining a minimum of 20 Pa over atmospheric pressure for the service life of the filter. [1]
- HEPA pressuriser filter and return air filters to be high efficiency HEPA filters tested & certified to capture submicron particles at the most penetrating particle size of 0.3 microns with 99.97% efficiency as per EN1822. [1][2]
- Fresh air volume at minimum of 30m³/h for one person cabin required to avoid carbon dioxide ($CO_2$) build-up. [1]
- In Cabin Pressure Display to let operator know that the system is working correctly and/or alert the operator if there is a fault. [1]
- As part of an E.B.D.M.P. (evidence based dust management plan) dust concentrations inside the cabin should be recorded, monitored & audited. [3]

Breathe-Safe submits when all this factors are collectively applied in a system, respirable size particles are controlled to practically zero. (See evidence in Appendix A picture 3).

With a test that was carried out with a cabin which we found actual separation efficiency level was close to that of a clean room standard. The qualifying Breathe-Safe system is able to record data and be remotely monitored for performance parameters of the enclosure which can alert mine site management of any issues and is able to comply with the imperative of keeping records.

[1] EN15695-1:2009. Agricultural tractors and self-propelled sprayers – Protection of the operator (driver) against hazardous substances – Part 1: Cab classification

[2] EN1822-1: 2009 High efficiency filters (HEPA and ULPA). Classification, performance testing, marking.

[3] AIOH submission – Coal Workers' Pneumoconiosis (CWP) Select Committee, November 2016.

Breathe-Safe endorses the recommendations of the Australian Institute of Occupational hygienists (AIOH) submission to the committee which outlined the necessity for the development and implementation of an evidenced based dust management plan which includes:

“mandated engineering controls such as closed air-conditioned cabs and properly engineered crushers and other plant”

“independent audit and review process”

Breathe Safe has identified organisations that can test these systems in the field for efficiency to local standards and to NIOSH studies in regards to protection factors.

## Conclusion

CWP is caused by exposure to respirable particles.

Preventing future cases means eliminating or at least minimising exposure: keeping exposure as low as reasonable practicable (ALARP) legislation.

European standard EN15695 Cat 4 should be a minimum example requirement compliant with HEPA filters tested as per EN1822 to practically remove respirable particles from the breathing zone of the operator.

Looking to the future we must ensure that that any pressurisation / filtration system installed is monitored and/or audited to certify that it is effective at removing respirable particles through the service life of the machine.

Breathe-safe submits that by installing a pressurisation / filtration system that meets the minimum standard laid out in EN15695 CAT 4. The reduction in costly repairs & maintenance to the HVAC system by dust contamination will outweigh the cost of installing an effective pressurisation & filtration system for the removal of respirable particles.

As we do not know a safe limit. Then, we must aim to eliminate all exposure.

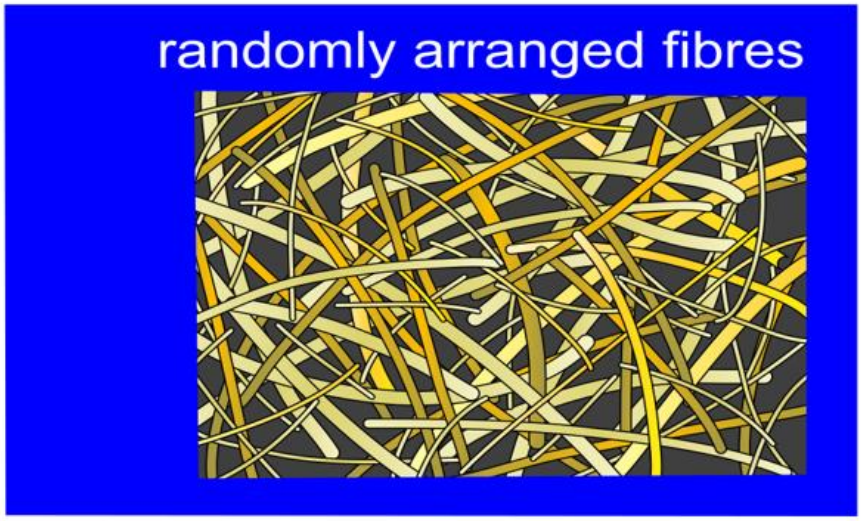
Appendix A – In-house filter testing with NATA certified optical particle counter.


Picture 1. Testing environment baseline particulate mass count.

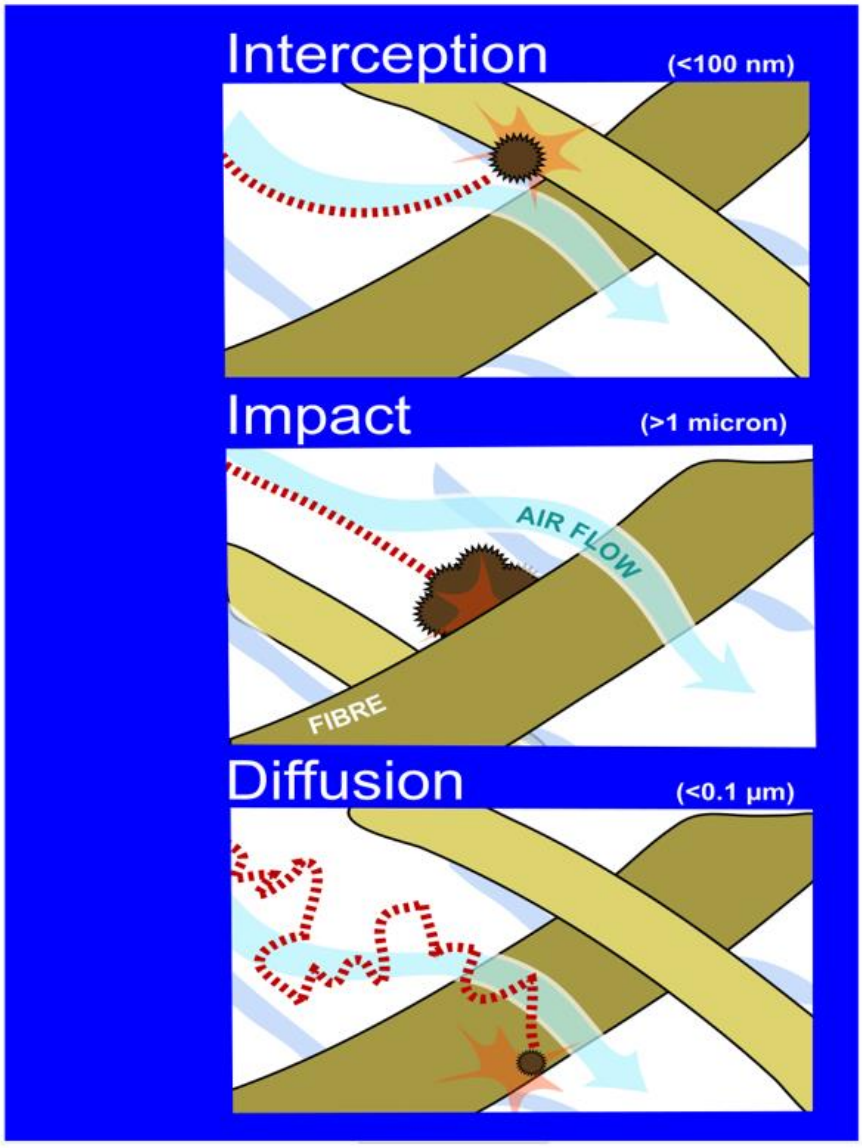

Picture 2. Typical OEM machine filter media as per ISO 5011 for filter testing and ISO 10263 1 to 4 Earth moving machinery – Operator enclosure environment.


Picture 3. Breathe-Safe pressuriser with H13 HEPA filter media tested as per EN1822

Appendix B – HEPA filter media diagrams




HEPA filter media is manufactured in a web of fibres randomly arranged. Particles become trapped in these following mechanisms:




Submicron particle moves with air flow direction and it is captured when it is very close (one radius of a fibre) resulting in touching and capture.
(Particle 0.4 micron and greater)

Nano particle is not able to change course in air flow direction and forced into contact with fibre becoming embedded.
(Particles 1 micron and greater)

Ultra-fine particle is affected by collisions with atoms and molecules in air and sets them in a random motion which then causes the particle to impact with the fibre.
(Particles below 0.1 microns)

Source: Wikipedia - By LadyofHats – infographic: [1], [2], [3], [4], [5], [6], [7], [8], [9]., Public Domain, https://commons.w kimedia.org/w/index.php?curid=4552953

Appendix C

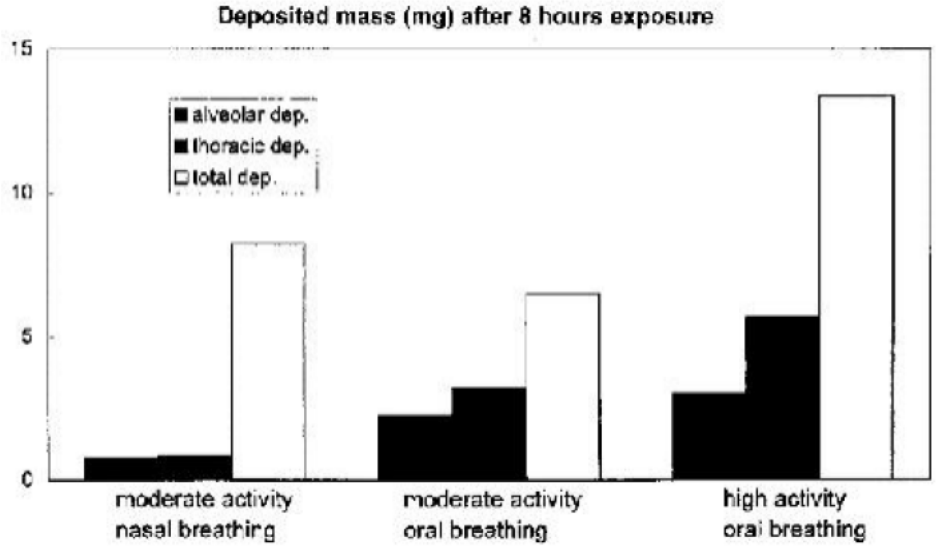
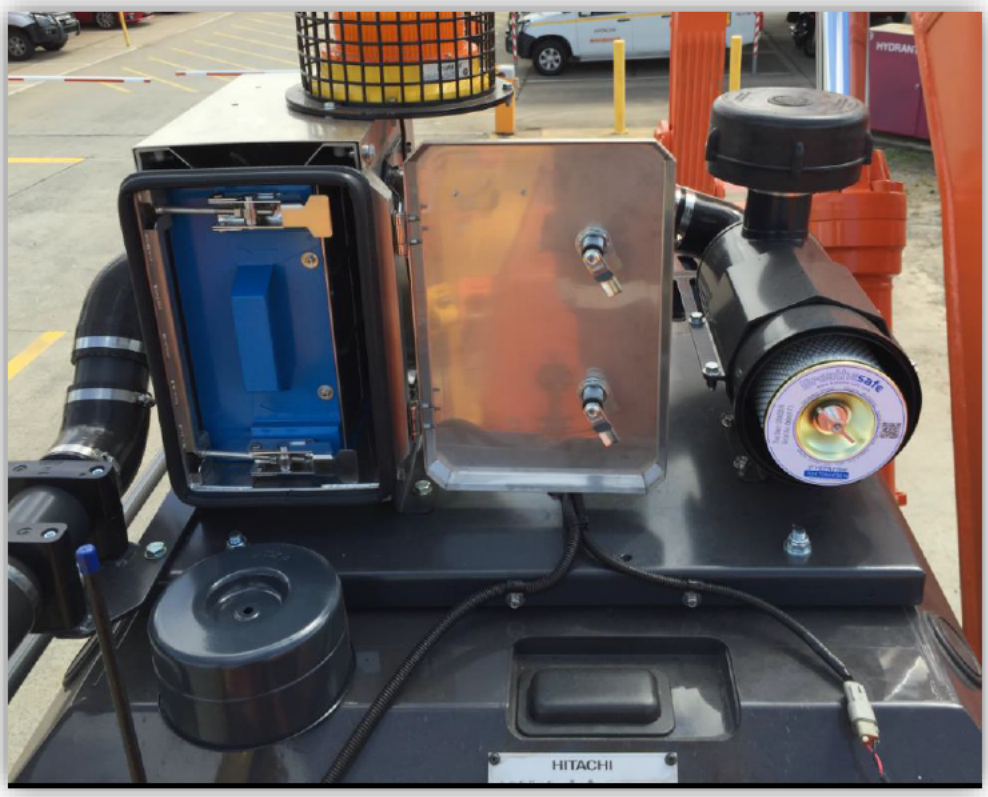



Figure 1-2 - Difference between nasal and oral breathing and the role of physical activity on the amount of dust inhaled and deposited in different regions of the respiratory airways (Fabriès, 1993) (by courtesy of J. F. Fabriès, INRS)

Picture 1. from: WHO / Hazard Prevention and Control in the Work Environment: Airborne Dust




Picture 2. Breathe Safe system equivalent to EN15695 Category 4 in qualifying cabin

Appendix D - Comparison of HVAC internal components using OEM and HEPA filter media.

Picture 1. OEM filter HVAC system internal components covered in dust . Accumulated over time eventually causing HVAC maintenance due to poor performance and/or HVAC failure.


Picture 2. HVAC system internal component with correctly maintained HEPA filters at 1500 hours of operation which shows clean system (HEPA Pressuriser and return air filters) .

Appendix E – ISO 10263 standard used for mining equipment (NSW. Draft standard, 2015).

Draft design rule NSW (Sample)

### *3.15.5 Heating, demisting and fresh air supply*

*Heating, demisting and fresh air supply should be provided as follows:*

*• be capable of adequately demisting the operator's cabin window*

*• supply filtered external makeup air sufficient to maintain a positive pressure inside the operator's cabin with windows and doors closed*

*• the air supply system should make adequate allowance for deterioration of door and window seals*

*• the heater should have isolating valves fitted to both supply and return lines adjacent to the engine to allow changing of heater hoses and/or core without disturbance to the engine cooling system.*

*Guidance on the operator enclosure environment is given in ISO 10263 Parts 1 to 6.*

***Breathe-Safe calls for these qualifying factors related to EN15695 standard for hazardous environment.***

- ***HEPA filters tested to EN1822 for control respirable dust.***
- ***Pressure display to let operator know that system is working or alert operator of malfunction.***
- ***Remote and/or continuous monitoring.***