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WORKER X

RESPIRABLE DUST EXPOSURE AND THE ASSOCIATED RISK OF PNEUMOCONIOSIS

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REPORT - AUGUST 2017

WORKER X - RESPIRABLE DUST EXPOSURE AND THE ASSOCIATED RISK OF PNEUMOCONIOSIS

1. EXECUTIVE SUMMARY

This report has been prepared so as to address the case of Worker-X and his exposure to respirable dust and the associated risk of lung disease. During 1985-2014 Workers-X was employed for 27 years as an operator with duties of driving a haul truck, with a small amount of dozer and push cut work in open cut coal mines in the Singleton mining district. In late 2016 he developed rapid onset and severe lung fibrosis with a considerable loss of lung function. The symptoms mimicked more closely those of silicosis rather than coal workers pneumoconiosis and hence were labelled as mixed dust pneumoconiosis. An alternate diagnosis of idiopathic pulmonary fibrosis was provided from another practitioner.

The occupational history and comments on dust provided by Worker X are unremarkable in that they reflect the standard work activities and actions undertaken by haul truck drivers in the mining industry.

The personal respirable dust and respirable crystalline silica (quartz) results obtained by occupational hygienists from Coal Services were collated for the mine sites relevant to the employment periods for Worker X, in addition the results from Truck and Dozer operators from all OC in the Singleton District were obtained for the relevant periods from 1985 to 2014. The two sets of exposure data were essentially similar. The mean and range of the respirable 'mixed coal' dust samples from 1985-2014 was much less than the regulatory exposure standard. The mean of the respirable quartz dust samples from 1985-2014 was less than the regulatory exposure standard, a small number of respirable quartz samples from the first employment period pre 2000 exceeded the regulatory exposure standard.

The cumulative exposure for the 6 employment periods amounted to 6.8mg/m^3.years of respirable 'mixed coal' dust which included 1.55 mg/m^3.years of respirable quartz. In overview, Worker X commenced in the industry in 1985 initially experiencing to 2005, 19 years of possibly the highest respirable dust, with the highest % quartz (25-30%) in the respirable dust samples producing highest respirable quartz exposure periods (83% and 90% of his working life respirable dust and respirable quartz exposures respectively). Followed by a further 6 years of lesser exposures (now at 96 % and 98% of his working life respirable dust and respirable quartz exposures).

Worker X's cumulative respirable dust and respirable quartz exposure was used to estimate the following levels of risk;

- Considering respirable coal dust (<5% quartz) by itself - around 1 in 10,000 for developing CWP Category 2, and 1 in 6,600 of developing PMF.
- Considering respirable quartz by itself - 1 in 500 for developing Silicosis 1/0 or higher.
- Considering a mixture of respirable coal dust and elevated respirable quartz dust, after applying the IOM [redacted] multi opencast mine model predicts ~ a 1 in 200 risk of category 2/1+ mixed dust pneumoconiosis and a risk of ~ 1 in 400 for developing PMF.

The rapid onset and progression of the medical symptoms and radiological evidence from Worker-X do not fit comfortably with the tasks undertaken as listed in the employment history, they do not fit comfortably with the associated measured exposures for haul truck operators in the Singleton district, they do not fit comfortable with the various risk estimates for pneumoconiosis, do not fit comfortably with the findings of Coal Services medical surveillance program, and do not fit comfortably with the published epidemiological studies on coal miners. Alternative aetiology is likely.

Alan Rogers
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2. **SCOPE OF THE REPORT**

A request was received from the Major Investigations and Emergency Response Unit, NSW Resources Regulator to conduct an examination of the exposure risk to respirable silica and respirable coal dust at Hunter Valley open cut coal mines specifically as it relates to the employment duties carried out by Worker X. Specifically to;

i. Review interview plan for the injured party (interview transcript - 63 pages)

ii. Review the brief of evidence consisting of approximately 200 separate relevant documents and determine the exposure risk profile for the injured party.

iii. Create a report that assesses the risk controls at the workplaces and compare to industry best practice

3. WORKER X - OCCUPATIONAL HISTORY:

[The following information has been pieced together from information contained in the Record of Interview conducted by Inspector [redacted] on 22 May 2017 and contained in the medical records of Worker X recorded periodically by Coal Services. There are some minor discrepancies between the dates and durations worked post 2000 but it is considered they are unlikely to effect the overall exposure and risk assessment process since Worker X maintained the same style of work during his employment during this time].

Worker X was born in 1965, he resided and was schooled at Muswellbrook NSW. His father was an electrical fitter at the adjacent Muswellbrook Coal Mine which fed coal to Muswellbrook power station. Their family house was provided by the mining company, [redacted] located at the back of Number One underground coal mine where his father worked.

Worker X claims he has never smoked tobacco.

Worker X progressed through the following employment periods.

1981-1983 - TLE Electrical-wholesalers. Worker X left school in year 10 (at age ~16), and took up employment in the stores for TLE. There was no coal dust exposure, possibly occasionally very low exposure to asbestos when handling electrical gear that may have contained bonded asbestos.

1983-1984 - Toshiba Bayswater Power Station. He was working in the power station store during construction phase and prior to the stations commissioning.

3.1 February 1985-June 1999 - Muswellbrook-Coal - he was employed as an Operator by at Muswellbrook Number 2 Open-cut. Initially work for around the first 10 years involved haul Truck Driver duties, initially he did two weeks training in a 35 tonne Euclid truck under the bins and then commenced working night shifts driving a 190 Euclid. He drove the truck up to the shovel/excavator in the pit where it was loaded then hauled overburden to the waste dump or hauled coal to the bins (the crusher was not operational during night shift). He estimated ratio overburden stripping to coal as around 8 to 1. The dozers were used for clean up around the shovel and for cross ripping sandstone and limestone beds. After the amalgamation of unions in 1993, he undertook additional duties in 1994 on dozers (D9's, D10's, D11's) and a push Cat and obtained his training ticket, later there were Komatsu 730E trucks. As well as mainly trucking in this later period he also became a first aider and spend time working in, and cleaning out the bath house. During the entire period all vehicles he worked in were enclosed cab types, Worker X commented that some of the earlier ones leaked dust and there was mud and dust taken into the cabs on operator's boots.

Duration of employment 14 years 5 months. The first 9-10 years he did night shift as a truck driver them for 4 ½ years on rotating shifts on a mixed range of vehicles consisting of trucks, dozers and push Cats, not all shifts or part shifts involved driving these vehicles.

3.2 November 2000- 2005 - United Mining Support Services employed as a contractor at various mines (Drayton, Liddell and Mt Owen). Worked as an Operator hauling overburden and also coal to the crusher.

Duration of employment ~4 ½ years as a haul truck driver.

3.3 2005-August 2011 - Pegasus (Ashton Coal)– The mine ran as a truck and excavator operation, with only two shifts per day and no nightshift. He was a contracted Operator and ran one of the newer Komatsu 730E haul trucks. He was a contractor on site from start up to completion of the mine.

Duration of employment ~6 years as a haul truck driver.

3.4 August 2011-October 2012 - Bulga Coal Operator for crib relief, 4 days a week between shifts, did other odd jobs apart from crib relief trucking. It appears he took a four month break during this period.

Duration of employment ~10 months crib relief haul truck driver.

3.5 October 2012-October 2013 - Mt Owen Mine (Thiess) he was a full time Operator including at Mt Ravensworth (Tessa, Skilled, One Key, Chandler) Then he took a 5-6 month break went up the coast.

Duration of employment 1 year haul truck driver.

3.6 2014 - Chandler MacLeod (Mt Arthur Mine) For 3 months he did Crib Relief for truck drivers on rotating shifts including night shifts. He was made redundant and took off up the coast towards Queensland, he made it to [redacted] where he had previously lived but felt ill so he stayed there 12 months then went back down to [redacted]. Has not worked since.

Duration of employment 3 months as haul truck driver.

Worker X commenced as a truck driver hauling coal and overburden in an open cut coal mine at age 20, continued in this line of work in an enclosed air conditioned cabin, ceasing around mid 2014, allowing for various breaks his duration of exposure amounted to around 27 years.

4. RESPIRABLE DUST EXPOSURE DATA

Occupational exposure to airborne dust in the NSW coal industry is required to be kept below certain limits. The limits relevant to this investigation are based on the 8 hour Time Weighted Average (TWA) concentrations of dust, collected and analysed according to Australian Standard AS 2985 -2004 *Workplace Atmospheres – Method for the Sampling and Gravimetric Determination of Respirable Dust*, and where required the crystalline silica content measured according to *Methods for Measurement of Quartz in Respirable Airborne Dust by Infra-red Spectroscopy and X-ray Diffractometry, NHMRC 1994*. The numeric values for respirable dust and respirable quartz in NSW Open Cut Coal are as follows;

Respirable Coal Dust - 1983-2004 3.0 mg/m^3 2005 – Current 2.5 mg/m^3

[This is measured as the total mass of respirable aerosol particulate and is not necessarily pure coal dust but consists of a varying mix of coal, silicates from over and inter burden, and crystalline silica/quartz from sources such as coal, overburden and geological intrusions. The coal dust standard applies to dust with less than 5% quartz.]

Respirable Quartz Dust - 1983-2004 0,15 mg/m^3 2005 – Current 0.1 mg/m^3.

Order No 42 of the Coal Industry Act 2001 requires the regular collection and analysis of samples of airborne dust from the breathing zone of people whose health may be affected by the dust. For open cut operations sampling is to be conducted at intervals not exceeding twelve months and samples of respirable dust, inhalable dust and respirable quartz containing dust is to be collected from the breathing zone of at least five persons including, where possible: drill operators, shotfirers and stemmers and mobile equipment operators.

The personal respirable dust and respirable crystalline silica (quartz) results obtained by occupational hygienists from Coal Services and also taken by occupational hygienists at one of the sites were collated for the mine sites relevant to the employment periods for Worker X. Further exposure data was provided by Coal Services on all Truck and Dozer operator dust samples from the Singleton District OC mines in the relevant periods from 1985 to 2014.

Occupational hygiene data tend to follow a log-normal distribution hence log-normal statistical treatment and descriptors is applied to determine compliance, however as the average exposure data is used in epidemiological studies and risk assessments, the average (arithmetic mean) exposure to coal and quartz dust was derived from the available data sets supplied by Coal Services and the on-site Occupational Hygienists. Some of the respirable dust results were listed to 1 decimal point others to two, less than values were taken as ½ values for calculation of the mean. Two dust and corresponding quartz results were excluded as they were well out of character with the remaining results and had possibly been tampered with.

4.1 February 1985-June 1999 - Muswellbrook Coal –

Truck drivers 0.9 ('86) 0.35('87) 0.44 ('90) 0.06 ('90) 0.23 ('92) 0.1 ('95) 0.1 (96) 0.1 ('97) 0.7 ('97) 0.1 ('99) mg/m^3
n=10, $\bar{X}$**= 0.31 mg/m^3** range 0.06-0.9 mg/m^3

Dozer drivers 0.23 ('84) 1.62 ('86) 0.28 ('87) 0.96 ('93) 0.24 ('93) 0.9 ('94) 0.2 ('94) 0.1 ('94) 0.2 ('95) 0.3 ('95) 0.3 ('96) 0.2 ('96) 0.9 ('99) mg/m^3
n=13, $\bar{X}$ **= 0.49 mg/m^3** range 0.1-1.62 mg/m^3
Respirable quartz 6-7% 2 samples loader drivers (1 coal, 1 inter-burden)

Trucks - All Singleton District Dust n= 160, $\bar{X}$ **= 0.31 mg/m^3** range 0.1-1.5 mg/m^3
Trucks - All Singleton District Quartz n= 4, $\bar{X}$ **= 0.13 mg/m^3** range 0.04-0.33 mg/m^3
Respirable quartz on the 4 samples 10-25% , all from high dust samples and working overburden, to allow for coal haulage apply $\bar{X}$ **= 0.07 mg/m^3** as per next work period

Dozer - All Singleton District Dust n= 169, $\bar{X}$ **= 0.36 mg/m^3** range 0.01-1.6 mg/m^3
Dozer - All Singleton District Quartz n= 5, $\bar{X}$ **= 0.10 mg/m^3** range 0.06-0.17 mg/m^3

4.2 November 2000- 2005 United Mining Support Services –
contractor at various mines (Drayton, Liddell and Mt Owen).
Drayton n=13, $\bar{X}$ **= 0.17 mg/m^3** range 0.1-0.4 mg/m^3
Liddell OC n=3, $\bar{X}$ **= 0.20 mg/m^3** range 0.2-0.2 mg/m^3
Mt Owen n=11, $\bar{X}$ **= 0.21 mg/m^3** range 0.1-0.7 mg/m^3
Combined 3 mines $\bar{X}$ **= 0.19 mg/m^3**

Truck - All Singleton District Dust n= 91, $\bar{X}$ **= 0.23 mg/m^3** range 0.1-2.0 mg/m^3
Truck - All Singleton District Quartz n= 4, $\bar{X}$ **= 0.07 mg/m^3** range <0.01-0.11 mg/m^3

4.3 2005-August 2011 Pegasus (Ashton Coal)

Truck Drivers 0.1 ('06) 0.1 ('08) no result ('09) 0.1 ('11) mg/m^3 all working overburden.
n=2, $\bar{X}$ **= 0.1 mg/m^3** range 0.1-0.1 mg/m^3
Respirable Quartz 7.5 – 22% (mean 15%) in 4 samples taken on drillers.

Truck - All Singleton District Dust n=195, $\bar{X}$ **= 0.14 mg/m³** range 0.1-0.8 mg/m³
Truck - All Singleton District Quartz n=37, $\bar{X}$ **= 0.02 mg/m³** range <0.01-0.08 mg/m³

4.4 August 2011-October 2012 Bulga Coal Operator for crib relief

Truck Drivers 0.1 ('11) 0.1 ('12) 0.1 ('12) 0.1 ('12) 0.1 ('12) 0.1 ('12) 0.1 ('12) 0.2 ('12) mg/m³
all samples when hauling coal
n=8, $\bar{X}$ **= 0.11 mg/m³** range 0.1-0.2 mg/m³
Respirable crystalline silica 2% crystalline on 2 samples taken on shot-firers

Truck - All Singleton District Dust n= 81, $\bar{X}$ **= 0.17 mg/m³** range 0.1-1.0 mg/m³
Truck - All Singleton District Quartz n= 19 $\bar{X}$ **= 0.01 mg/m³** range <0.01-0.06 mg/m³

4.5 October 2012-October 2013 Mt Owen Mine (Thiess) full time haul truck Operator

Truck Driver **0.08** ('13) mg/m³
Respirable crystalline silica 8% crystalline silica taken on grader driver, & 2 excavator Drivers

Truck - All Singleton District Dust n= 38, $\bar{X}$ **= 0.17 mg/m³** range 0.02-0.61 mg/m³
Truck - All Singleton District Quartz n= 13, $\bar{X}$ **= 0.01 mg/m³** range <0.01-0.05 mg/m³

4.6 2014 Chandler MacLeod (Mt Arthur Mine) Worker X did Crib Relief haul trucks

No samples taken by CS on truck drivers in 2014, dozer drivers 0.1, 0.02, 0.37 mg/m³
Respirable crystalline silica 3% for samples taken on dozer driver,

Mt Arthur Occupational Hygienist dust results sampling first 6 months 2014 –
Operator Mining - 0.1, <0.1, <0.1, 0.3, 0.4, 0.1, 0.1, 0.4 mg/m³
n=8, $\bar{X}$**= 0.19 mg/m³** range <0.1-0.4 mg/m³

Truck - All Singleton District Dust n= 21, $\bar{X}$ **= 0.11 mg/m³** range 0.01-0.15 mg/m³
Truck - All Singleton District Quartz n= 4, $\bar{X}$ **= 0.02 mg/m³** range <0.01-0.02 mg/m³

For the period 1985 to 2014 there were 755 respirable dust sample results relating to haul truck drivers of which 84 were analysed for quartz and the results provided. For the period 1985- to 2000, 169 respirable dust results were available for dozer drivers of which 5 were analysed for respirable quartz.

On the sites during the periods when Worker X was employed there was 56 truck driver respirable dust samples, but no respirable quartz results were available for truck drivers during these sites for the employment periods. For the first period of Worker X's employment he did some work on dozers, and there were 13 dozer driver respirable dust samples recorded for this site, no quartz analysis was conducted on these samples.

1985-1999 Muswellbrook Coal - The mean of the truck driver site respirable dust samples 0.31 mg/m^3 was the same as the all Singleton truck driver respirable dust samples indicating consistency. The respirable quartz levels were higher than all other periods for Worker X with mean value of 0.12 mg/m^3 (39% quartz in the respirable dust). This may be an artefact of the small number of only 5 samples tested and the samples for quartz analysis appear to be selected from the highest respirable dust samples, if more respirable dust samples had been analysed for quartz to cover more typical work activities, the mean respirable quartz levels for truck drivers would have been much lower.

For dozer drivers the mean exposure on site is 36% higher than for the dozer drives on all Singleton OC sites in the period, again reflecting selective sampling.

2000-2005 contractor at various mines - The mean of the truck driver respirable dust samples 0.19 mg/m^3 for three of the sites remembered by Worker X is 83% of the mean of 0.23 mg/m^3 for all truck driver samples for Singleton sites in the period. The mean respirable quartz exposure 0.07 mg/m^3 is less than for the previous employment period but higher than for the next employment period.

2005-2011 Pegasus - The mean of the truck driver respirable dust samples 0.10 mg/m^3 for the site is 71% of the mean of 0.14 mg/m^3 for all truck driver samples for Singleton sites in the period, this is likely to be an artefact since there was only two samples taken on the site during the period. The mean respirable quartz exposure 0.02 mg/m^3 is less than for the previous employment period but slightly higher than for the next employment periods.

2011-2012 Bulga Coal - The mean of the truck driver respirable dust samples 0.11 mg/m^3 for the site is 65% of the mean of 0.17 mg/m^3 for all truck driver samples for Singleton sites in the period.

2012-2013 Mt Owen Mine–- Only one respirable dust sample was taken on a truck driver in the period and this was 47% of the mean of 0.17mg/m^3 for all truck driver samples for Singleton sites in the period.

2014 Mt Arthur - The mean of the operator respirable dust samples taken by the site occupational hygienists 0.19 mg/m^3 for the site is 173% of the mean of 0.11 mg/m^3 for all truck driver samples for Singleton sites in the period.

It is not possible to determine if the differences listed above are artefacts due to the differences in the number of samples taken between mines or due to better controls and work practices on the various mine sites.

The occupational history and comments on dust provided by Worker X are unremarkable in that they reflect the standard work activities and actions undertaken by haul truck drivers in the mining industry. The levels of respirable dust recorded in open cut haul truck operators in the Singleton District and Hunter Area is similar to the levels of respirable dust I have monitored over a number of decades on haul truck drivers in open cut, underground & waste dump operations associated with metalliferous and extractive industry mines.

5. WORKER X - CUMULATIVE RESPIRABLE DUST EXPOSURE

The epidemiological evidence indicates that risk of developing pneumoconiosis (e.g. silicosis, coalminers' pneumoconiosis, mixed dust pneumoconiosis etc,) is best represented by a dose response relationship. The higher the dose of dust the higher the risk of disease. The dose is expressed as a working life cumulative exposure obtained by multiplying the long-term average daily dust exposure of the workforce, by the proportion of time they are exposed in the week or year and also by the number of years that they are so exposed. The resultant value is expressed in milligram of respirable dust per cubic metre of air x years (mg/m^3.years). One hundred mg/m^3.years is the cumulative dose that would result from, for example, exposure to a **constant 8 hours a day 5 days a week average** respirable dust concentration of 10 mg/m^3 over 10 years, or 2.5 mg/m^3 over 40 years (i.e. 2.5 mg/m^3 x 40 years = 100 mg/m^3.years).

The site specific and working life cumulative exposure for Worker X is calculated as follows;

5.1 February 1985-June 1999 - Muswellbrook Coal

Duration of employment/exposure 14 years 5 months. The first 9-10 years he did night shift as a truck driver them for 4 ½ years on rotating shifts on a mixed range of vehicles consisting of trucks, dozers and push Cats, not all shifts or part shifts involved driving these vehicles. Mean exposure trucks 0.31 mg/m^3, mean exposure dozers 0.49 mg/m^3

Cumulative Respirable Dust Exposure Period 1:

Site Dust samples - 10yrs x 0.31 mg/m^3 + 4.5yrs x (0.31 + 0.49) ÷ 2 mg/m^3
= 3.1 + 1.8 mg/m^3.years
= 4.9 mg/m^3.years respirable dust

Singleton Dist. Dust Samples - 10yrs x 0.31 mg/m^3 + 4.5yrs x (0.31 + 0.36) ÷ 2 mg/m^3
= 3.1 + 1.5 mg/m^3.years
= 4.6 mg/m^3.years respirable dust

5.2 November 2000- 2005 United Mining Support Services

Duration of work/exposure ~4 ½ years as a contractor truck driver various mines hauling overburden and also coal to the crusher. The 3 mine combined average exposure data for truck drivers of 0.19 mg/m^3 was used.

Cumulative Respirable Dust Exposure Period 2

Truck- Site Dust samples - 4.5 yrs x 0.19 mg/m^3 = 0.86 mg/m^3.years
Truck- Singleton District Samples - 4.5 yrs x 0.23 mg/m^3 = 1.04 mg/m^3.years

5.3 2005-August 2011 Pegasus (Ashton Coal)

Duration of work/exposure ~6 years as contractor truck driver. Mean exposure truck drivers on this site 0.1 mg/m^3.

Cumulative Respirable Dust Exposure Period 3

Truck- Site Dust Samples - 6 yrs x 0.1 mg/m^3 = 0.60 mg/m^3.years
Truck- Singleton District Samples - 6 yrs x 0.14 mg/m^3 = 0.84 mg/m^3.years

5.4 August 2011-October 2012 Bulga Coal

Duration of work/exposure ~10 months crib relief trucking. Mean exposure truck drivers on this site 0.11 mg/m^3

Cumulative Respirable Dust Exposure Period 4

Truck- Site Dust Samples - 10/12 yrs x 0.11 mg/m^3 = 0.09 mg/m^3.years
Truck- Singleton District Samples - 10/12 yrs x 0.17 mg/m^3 = 0.14 mg/m^3.years

5.5 October 2012-October 2013 Mt Owen Mine (Thiess)

Duration of work/exposure 1 year as truck driver. Only one sample taken in the period on a truck driver 0.08 mg/m^3

Cumulative Respirable Dust Exposure Period 5

Truck- Site Dust Samples - 1 yr x 0.08 mg/m^3 = 0.08 mg/m^3.years
Truck- Singleton District Samples - 1 yr x 0.17 mg/m^3 = 0.17 mg/m^3.years

5.6 2014 Chandler MacLeod (Mt Arthur Mine)

Duration of work/exposure 3 months crib relief truck driver. Mean exposures on truck drivers 0.19 mg/m^3.

Cumulative Respirable Dust Exposure Period 6

Truck- Site Dust Samples - 3/12 yrs x 0.1 9 mg/m^3 = 0.05 mg/m^3.years
Truck- Singleton District Samples - 3/12 yrs x 0.1 1 mg/m^3 = 0.03 mg/m^3.years

Worker X - Total Cumulative Respirable Dust Exposure in Open Cut Coal Mining Industry

The sum of the ~27 years in total work duration/exposure for the cumulative exposure employment periods 1 to 6 amounting to;

Site OC Mine truck driver Respirable Dust Samples

Period 1 (4.9 mg/m^3.yrs) + Period 2 (0.86 mg/m^3.yrs) + Period 3 (0.60 mg/m^3.yrs) + Period 4 (0.09 mg/m^3.yrs) + Period 5 (0.08 mg/m^3.yrs) + Period 6 (0.05 mg/m^3.yrs)
= 6.6 mg/m^3.years

All Singleton District OC mine truck driver Respirable Dust Samples

Period 1 (4.6 mg/m^3.yrs) + Period 2 (1.04 mg/m^3.yrs) + Period 3 (0.84 mg/m^3.yrs) + Period 4 (0.14 mg/m^3.yrs) + Period 5 (0.17 mg/m^3.yrs) + Period 6 (0.03 mg/m^3.yrs)
= 6.8 mg/m^3.years

6. WORKER X - CUMULATIVE RESPIRABLE QUARTZ EXPOSURE

There was no respirable quartz measurements made on truck drivers at the time for the mine sites relevant to the employment periods of Worker X. The CS respirable quartz measurements made on truck drivers for all Singleton District OC mines during the relevant times as listed in Section 4 were applied in the following estimated cumulative exposures.

6.1 February 1985-June 1999 - Muswellbrook Coal

Cumulative Respirable Quartz Exposure Period 1

Singleton - Quartz Samples - 10yrs x 0.07 mg/m^3 + 4.5yrs x (0.07 + 0.10) ÷ 2 mg/m^3
= 0.7 + 0.38 mg/m^3.years
= 1.08 mg/m^3.years respirable quartz

6.2 November 2000- 2005 United Mining Support Services

Cumulative Respirable Quartz Exposure Period 2

Truck- Singleton District Quartz Samples - 4.5 yrs x 0.07 mg/m^3 = 0.32 mg/m^3.years

6.3 2005-August 2011 Pegasus (Ashton Coal)

Cumulative Respirable Quartz Exposure Period 3

Truck- Singleton District Quartz Samples - 6 yrs x 0.02 mg/m^3 = 0.12 mg/m^3.years

6.4 August 2011-October 2012 Bulga Coal

Cumulative Respirable Quartz Exposure Period 4

Truck- Singleton District Quartz Samples - 10/12 yrs x 0.01 mg/m^3= 0.01 mg/m^3.years

6.5 October 2012-October 2013 Mt Owen Mine (Thiess)

Cumulative Respirable Quartz Exposure Period 5

Truck- Singleton District Quartz Samples - 1 yr x 0.01 mg/m^3 = 0.01 mg/m^3.years

6.6 2014 Chandler MacLeod (Mt Arthur Mine)

Cumulative Respirable Dust Quartz Exposure Period 6

Truck- Singleton District Quartz Samples - 3/12 yrs x 0.02 mg/m^3= 0.005 mg/m^3.years

Worker X - Total Cumulative Respirable Quartz Exposure in Open Cut Coal Mining Industry

The sum of the ~27 years in total work duration/exposure for the cumulative respirable quartz exposure employment periods 1 to 6 amounting to;

Singleton District Respirable Quartz Truck Driver Samples -

Period 1 (1.08 mg/m^3.yrs) + Period 2 (0.32 mg/m^3.yrs) + Period 3 (0.12 mg/m^3.yrs) + Period 4 (0.01 mg/m^3.yrs) + Period 5 (0.01 mg/m^3.yrs) + Period 6 (0.005 mg/m^3.yrs)

= 1.55 mg/m^3.years respirable quartz

The 14 ½ years working at Muswellbrook OC is the dominant quartz exposure period in Worker X's employment history amounting to around 70% of his cumulative respirable quartz exposure. The following period of 4 ½ years working as a contractor at various sites added around another 21% of respirable quartz exposure to the cumulative amount.

The cumulative respirable quartz amounts to around 23% of the overall cumulative respirable dust value and reflects the influence of a mix of work involving removal, hauling and dumping highly siliceous overburden and intrusive seams such as sandstone (>80% quartz) along with a similar process of coal which has a much lower quartz content (3-6%).

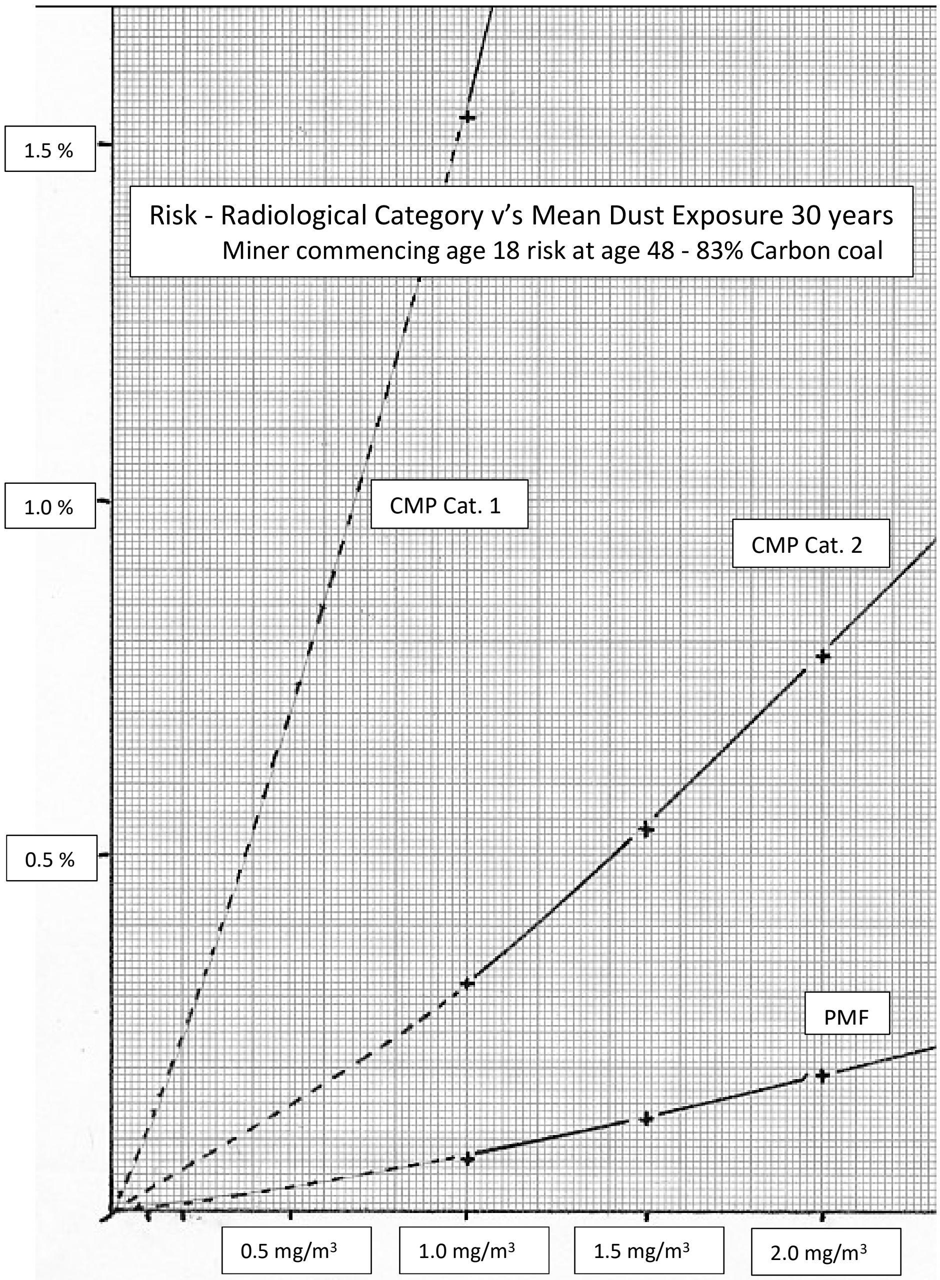
The interpretation of the level of quartz across sites and over long periods needs to be approached with some caution as the results are likely to be effected by a number of factors such as the work activities which are chosen to be sampled, and whether the respirable dust sample is selected to be sent to a specialised laboratory for quartz analysis.

Routine respirable quartz sampling in the coal industry commenced in 1983 with the introduction of the quartz exposure standard. Initially selective sampling for quartz analysis was targeted at high respirable dust samples and also in work situations where it was likely that there would be elevated quartz levels such as when cutting into stone roof and floors in underground and removal of overburden in open cut operations.

A second consideration was that for coal dust samples with a typical 3-5% quartz content, there is a requirement for the 8 hour sampling duration the respirable dust level needs to be higher than around 0.2 mg/m^3 to provide a result which is greater than the analytical detection level. Hence low respirable dust levels such as found with a large proportion of truck driver samples were not sent for quartz analysis and consequently the reporting of respirable quartz levels for haul truck drivers and many other occupational groups is heavily biased towards the higher dust level samples.

7. WORKER X - PREDICTED RISK - COAL WORKERS PNEUMOCONIOSIS & PMF

Pneumoconiosis an interstitial lung disease associated with exposure to coal dust is termed coal workers pneumoconiosis (CWP). The cumulative respirable dust exposure result determined in Section 5 allows for the assessment of the level of risk for Worker X of developing CWP. The line for the pneumoconiosis categories, 1, 2 and PMF for 83% carbon coal can be extrapolated to mean exposure levels of less than 1 mg/m^3 and indicated in the following graph.



Average Respirable Coal Dust Exposure over 30 years

For the range of average exposures of 1.0 to 3 mg/m^3 the risk line or coefficient for each pneumoconiosis category is linear. If this linear extrapolation is extended to average exposures lower than 1 mg/m^3 down to the zero risk Y axis, the extrapolated line intersects the X (exposure) axis at a value above zero exposure indicating the presence or at least an appearance of a threshold below which the exposure results in no observed or no measurable level of risk.

The linear threshold model produces no-effect average exposures for 30 year duration of;

- 0.25 mg/m^3, (cumulative exposure 7.5 mg/m^3.years) for CWP Cat 1
- 0.40 mg/m^3, (cumulative exposure 12 mg/m^3.years) for CWP Cat 2
- 0.40 mg/m^3, (cumulative exposure 12 mg/m^3.years) for PMF

An alternative analysis of the data is to assume there is no threshold and then apply curve fitting to the lower end of the IOM model data extending it through zero risk and exposure as shown by the broken lines on the dose response risk graph. Such an approach requires that firstly the effect is biologically plausible and secondly the effect be detectable given the potential variability in interpretation of the diagnostic criteria between readers.

at 0.1 mg/m^3 (cumulative exposure 3 mg/m^3.years)

- Risk of developing CWP Cat 1 becomes 0.1 %,
- Risk of developing CWP Cat 2 becomes 0.025 %,
- Risk of developing PMF becomes less than 0.01% .

The relevant factors that closely match those for Worker X are age 20 at entry into the industry, 27 years of work in the industry mostly as haul truck driver, the cumulative respirable dust exposure after applying the relevant exposure data and employment time at the relevant mine sites of 6.8 mg/m^3.years, then his average exposure over the 27 years;

6.8 mg/m^3.years ÷ 27 years = 0.25 mg/m^3 average respirable dust level.

For the non-threshold estimation;

at 0.25 mg/m^3 (cumulative exposure 7.5 mg/m^3.years)

- Risk of developing CWP Cat 1 becomes 0.3 %, [1 in 330]
- Risk of developing CWP Cat 2 becomes 0.075 %, [1 in 1,300]
- Risk of developing PMF becomes 0.015%, [1 in 6,600]

It is not possible in a practical sense to say with any degree of certainty if a threshold does or does not exist. A conservative approach is to lean towards non-threshold risk estimations.

8. WORKER X - PREDICTED RISK OF SILICOSIS & MIXED DUST PNEUMOCONIOSIS

8.1 Silicosis: Pneumoconiosis an interstitial fibrotic lung disease associated with exposure to crystalline silica such as quartz is termed 'silicosis'. Using the mean quartz exposures obtained by Coal Services for OC truck drivers in the Singleton District in the relevant periods it is estimated in Section 6 that Worker X's cumulative exposure to crystalline silica was around 1.55 mg/m^3 .years respirable quartz.

Applying the silicosis risk data outlined [redacted], for Worker X to his purely cumulative respirable quartz exposure determines that his risk of developing radiological silicosis of Category 1/1 or greater is around 0.25% or less [1 in 400 or less].

8.2 Mixed Dust Pneumoconiosis - Pneumoconiosis an interstitial fibrotic lung disease associated with exposure to mixed mineral dusts which contain crystalline silica such as quartz is termed 'mixed dust pneumoconiosis'.

Worker X's cumulative exposure to respirable dust was estimated as 6.8 mg/m^3.years and 1.55 mg/m^3.years of respirable quartz which was accumulated over 27 years of work. This amounts to an average rate of exposure of 0.25 mg/m^3 respirable dust and 0.06 mg/m^3 respirable quartz. [redacted]

The IOM [redacted] risk model which uses data from a single underground mine, with its very high long term exposure scenarios produces 10 X high risk outcomes compared with the risk associated with pure quartz dust. Whether this is applicable to extrapolation to lower exposures found in contemporary mining situations remains subject to speculation.

The IOM [redacted] risk model based on studies in nine large and medium sized opencast sites in the UK produces a more realistic predicted risk which is closer to that produced by pure quartz exposure. The example selected in [redacted] was for a non- smoker, age 55, with 20 years in opencast preproduction area which is the highest respirable mixed dust and quartz exposure group, they would have experienced a 16% chance of pneumoconiosis category ≥ 1/0. Based on a simple comparison of the ratio of 1:10 for category 1 to category 2 PMF, the risk of developing category 2 is 16%/10 = 1.6% and for developing PMF with a ratio of 1: 25 the risk is 16%/25 = 0.6%.

Worker-X was age 51 at diagnosis, he was a non-smoker, and had 27 years in his job as a haul truck operator which meant he had lower exposures, around 30-50% less than the preproduction group used in the IOM [redacted] pneumoconiosis risk model. As such the risk is 30-50% of the above example values of developing category 2, around 0.5-0.8 %, and the risk of PMF with such exposures is around 0.2-0.3%.

9. WORKER X - SYMPTOMOLOGY v's PREDICTED RISK

The following sequence of Worker X's sequence of lung function and chest X-ray findings have been extracted from information supplied by Coal Services.

1985 231/1/1985 – employer listed as Muswellbrook Coal
listed as Pneumoconiosis Category 0
Lung Function FEV_1 - 3.9 (81.3% Predicted)
FVC - 4.7 (82.5% Predicted)

1998 28/1/1998 - employer listed as Muswellbrook OC
'last medical 13 years ago'
Nil shortness of breath
Lung Function FEV_1 - 3.7 (80% Predicted)
FVC - 4.6 (86% Predicted)

2000 4/12/2000 – pre-employment UMSS
'lung fields appear clear and no evidence of pulmonary or pleural disease'
'Nil dyspnoea'
'Pneumoconiosis Grade 0/0'
Lung Function FEV_1 - 3.25 (73% Predicted)
FVC - 4.10- (77% Predicted)

2001 22/8/2001 – pre-employment employer listed as Mining & Earthmoving
Request by Worker X release JCB pre-employment medical to himself
27/8/2001 Evaluation standardised functional capacity carried out JCB

2004 2/9/2004 - pre-employment requested by UMSS
Lung Function FEV_1 - 3.7 (88% Predicted)
FVC - 4.4 (87% Predicted)

2005 19/4/2005 – no employer listed
Request by Worker X to release pre-employment medical 2/9/2004 to himself

2007 1/3/2007 – no employer listed
1 page with no comments relevant to lung condition.

2009 7/8/2009 – no employer listed
Notification to Worker X recent health screening – now due for Chest X-ray.
Refer letter supplied, X-ray appointment not taken up?

2010 24/2/2010 - – no employer listed
Lung Function FEV_1 - 3.13 (88% Predicted)
FVC - 3.47 (80% Predicted)
'normal respiratory function', 'stressed by spirometer testing'

2011 21/11/2011 – requested by Pegasus Employment
Request made by CS for X-ray asked for 'check for presence/absence fibrosis, or industrial lung disease or evidence dust exposure'

Date of Chest X-ray 2/11/2011 ‘normal’
Lung Function FEV$_1$ - 3.19 83% Predicted
FVC - 3.27 68.7% Predicted
‘normal

In 2011 - Dr [redacted] found the 2011 chest X-ray to be normal, the report stated that the lungs and pleural spaces appeared clear, with no evidence of diffuse interstitial pulmonary fibrosis or inhalational lung disease.

In 2016 - Dr [redacted] examined the 2011 Chest X-ray, he found no evidence of classifiable parenchymal abnormalities, no evidence of pleural abnormalities and no other general abnormalities. He did find mild diffuse bronchial wall thickening with ill defined bronchovascular structures. He noted though that the finding was indeterminate with a range of possible causes.

2012 22/5/2012 – pre-employment request by Thiess Mt Owen
Date of Chest X-ray 2/11/2011 listed as ‘normal’
Lung Function FEV$_1$ - 2.69 72% Predicted
FVC - 3.29 71% Predicted
‘mild restriction’

2013 8/11/2013 – pre-placement Tesa Mining
‘Do you require a Chest X-ray’ checked on the form as ‘required’,
Date of Chest X-ray 1/5/2011
‘Last CXR 18/12 ago normal’,
‘no history of lung disease and normal CXR here in 2011’
Lung Function FEV$_1$ - 2.38 62.1% Predicted
FVC - 2.65 55.8% Predicted
‘poor technique today due to throat pain’
Spirometry Results ‘restricted’

2014 2/6/2014 -
request by Worker X for release of medical information to
One Key Resources, Fortitude Valley Qld.

2016 14/12/2016 - [redacted]
Chest X-ray (X2) -multiple bilateral small opacities 3/3 ILO t in shape, confluence of the opacities in the mid left zone with progressive massive fibrosis ILO category B.
Lung Function FEV$_1$ - 1.83 57% Predicted
FVC - 1.86 40% Predicted

‘The changes are totally compatible with mixed dust fibrosis, or a mixture of coal workers’ pneumoconiosis and silicosis. There is more fibrotic change evident than is usual with coal workers pneumoconiosis and there is some mild emphysema. I do not agree with the report [redacted] that the images are compatible with idiopathic pulmonary fibrosis.’

On the basis of the current information it was Dr [redacted] opinion that ‘Worker X has severe 3/3 complicated pneumoconiosis which is compatible with his past occupational exposure to coal dust and presumably to mixed dusts as well, including silica, in his job as a surface cut operator over the last 30 years.’

A summary of the respirable dust and respirable quartz exposures from Sections 5 and 6 and the incremental increases in cumulative exposures for the sequence and each employment period for Worker-X, produces the following table;

	RD mg/m^3		RQ mg/m^3		Ratio RD/RQ
1 [1985-1999]	4.6/6.8 =68%		1.08/1.55 =69.7%		1.08/4.6 = 23.5%
2 [2000-2005]	1.04/6.8 =15.3%	83.3%	0.32/1.55 =20.7%	90.4%	0.32/1.04 = 30.8%
3 [2005-2011]	0.84/6.8 =12.4%	95.7%	0.12/1.55 =7.7%	98.1%	0.12/0.84 = 14.3%
4 [2011-2012]	0.14/6.8 =2.1%	97.8%	0.01/1.55 =0.7%	98.8%	0.01/0.14 = 7.1%
5 [2012-2013]	0.17/6.8 =2.5%	100.3%	0.01/1.55 =0.7%	99.5%	0.01/0.17 = 5.9%
6 [2014]	0.03/6.8 =0.5%	100.8%	0.005/1.55 =0.3%	99.8%	0.005/0.03 = 16.7%

In overview, Worker X commenced in the industry in 1985 initially experiencing to 2005, 19 years of possibly the highest respirable dust, with the highest % quartz 25-30% in the respirable dust samples producing highest respirable quartz exposure periods (83% and 90% of his working life respirable dust and respirable quartz exposures respectively). Following a further 6 years of lesser exposures (now at 96 % and 98% of his working life respirable dust and respirable quartz exposures).

His chest X-ray taken in late 2011 (at latency of 26 years since first exposure on entering the industry) was reported as showing no evidence of pneumoconiosis. His lung function tests indicated FEV_1 remained at 83% of the predicted value (similar to when he commenced in the industry in 1985) and his FVC had reduced to 68% of predicted, the results at the time were determined as 'normal' lung function (presumably the value was above the lower limit of normal for the reference values).

Worker-X continued to work as a haul truck driver for another 2¼ years (adding the final 4% respirable dust and 2% respirable quartz exposure) and during this period appears to have developed restrictive lung function. He ceased employment and within 2 years was diagnosed with severe mixed dust pneumoconiosis 3/3 with progressive massive fibrosis and experiencing severe loss of lung function.

The remarkable rapid onset in 5 years with progression to a severe stage and respiratory disability is atypical of CWP and it has been postulated is mainly due to excessive respirable quartz exposure (Dr [redacted]) or idiopathic pulmonary fibrosis (Dr [redacted]).

This effect has been reported in a few cases from groups of coal miners the in the UK and USA who have been exposed for long durations to high levels of respirable coal dust along with high exposures to respirable quartz dust. The long term high exposure conditions to respirable coal dust and respirable quartz dust and the prevalence of CMP in these international studies appear to be very different to the levels of exposure and the prevalence of pneumoconiosis in Singleton District coal mines.

The medical symptoms and radiological evidence from Worker-X do not fit comfortably with the tasks undertaken as listed in the employment history, do not fit comfortably with the associated measured exposures for haul truck operators in the Singleton district, and do not fit comfortable with the various risk estimates for pneumoconiosis. This poses the following questions.

9.1 Is the Rapid Progression and Severity Shown by Worker-X Typical?

The study of underground coal miners exposed to high levels of quartz in the coal dust provides some information on progression of simple pneumoconiosis and also the development of large opacities. Radiographs taken in previous surveys 1970, 1974 and 1978 were available for 1416 men, and 547 were traced and partook in the 1990/1991 follow up survey.

Comparisons were made between the findings in the 1990/91 survey against the last radiological findings, a progression period of at least 10-12 years and in some cases 16 years. The progression of small opacities were presented in the following table.

Table 4 Comparison of median readings of small opacities from follow up radiograph and from last previous PFR radiograph (values are numbers of men)

Last PFR radiograph	*Follow up radiograph*										
	0/0	*0/1*	*1/0*	*1/1*	*1/2*	*2/1*	*2/2*	*2/3*	*3/2*	*3/3*	*Total*
0/0	317	54	40	25	4	4	4	3	2	1	454
0/1	—	11	12	12	4	4	4	2	1	—	50
1/0	—	1	3	3	2	5	5	2	—	—	21
1/1	—	—	—	1	3	1	1	2	—	—	8
1/2	—	—	—	—	2	—	—	—	—	—	2
2/1	—	—	—	—	—	—	3	—	—	—	3
2/2	—	—	—	—	—	—	2	—	—	—	2
2/3	—	—	—	—	—	—	—	—	—	—	0
3/2	—	—	—	—	—	—	—	—	—	—	0
3/3	—	—	—	—	—	—	—	—	—	—	0
Not found	5	1	—	—	—	—	—	1	—	—	7
Total	322	67	55	41	15	14	19	10	3	1	547

After 10 or more years progression of one step was found in 75 cases (14%), and of two steps in a further 55 cases (10%). In 128 cases (24%) there was progression of two or more steps. Only 4 (0.7%) cases progressed from category 0 to category 3 in 10 years or more.

There were 14 radiographs taken at follow up where at least two of the three readers recorded the presence of large opacities. Also shown in the following table are the median profusions of small opacities for the same radiographs.

Table 5 Details of median readings for men classified by at least two readers as having large opacities on the follow up radiograph

Large opacities		*Small opacities*	
Last PFR radiograph	*Follow up radiograph*	*Last PFR radiograph*	*Follow up radiograph*
0	A	1/0	2/3
0	A	0/0	1/0
0	A	0/1	2/1
0	B	2/2	2/2
0	A	0/0	0/0
A	A	2/1	2/2
0	A	1/0	2/1
0	B	2/1	2/2
0	A	1/1	2/3
A	B	1/1	2/2
0	B	0/1	1/1
A	B	0/1	2/1
0	A	0/0	2/3
0	A	1/0	2/2

No cases with large opacities in the at least 10 year follow-up had progressed to small opacities category 3. For 6 of the 14 cases that had last radiograph indicated category 0, 1 had not had progressed in the follow-up, 2 had progressed to category 1, and 3 had progressed to category 2 with one of these which had shown large opacities A on the last radiograph and had progressed to B on follow up.

Even with the extremely high exposure to respirable quartz dust experienced by the underground coal miners, it was rare to find rapid progression in 10 years to a severe stage of pneumoconiosis and with severe respiratory disability.

The rapid onset in only 5 years with Worker-X with progression to a severe stage and respiratory disability is atypical.

9.2 Is the Dust Exposure of Worker-X a Valid Estimate?

During Workers-X's 27 years of employment he was a an open cut haul truck driver, apart from a brief period in his first employment where he was trained on dozers and a 'push Cat'.

Based on exposure data on haul truck drivers (and dozer operators) taken in the mines he worked and also in all Singleton district mines, the average exposure to respirable dust commenced at ~0.3 mg/m^3 reducing down to 0.1 mg/m^3 by the completion of his employment (averaged 0.25 mg/m^3 over the 26 years of employment or 8-10% of the allowable exposure standard). His average respirable quartz exposure commenced at around 0.07 mg/m^3 reducing down to 0.01 mg/m^3 by completion (averaged 0.06 mg/m^3 over the 26 years of employment or 50-60% of the allowable exposure standard).

A literature search of the published exposure data for operators in open cut coal mines indicates,

USA - Open Cut Coal Haul Truck Operator Exposures

Researchers reported respirable dust and respirable quartz exposures in US surface coal mines for period 1982-1986 ;

Coal Truck Driver
- Inspectors respirable dust samples n= 859, 1% > 1 mg/m^3, $\bar{X}$ = 0.5 mg/m^3
- Company respirable dust samples n= 1597, 2% > 1 mg/m^3, $\bar{X}$ = 0.4 mg/m^3
- Inspectors respirable Quartz samples n= 33, 40% > 0.1 mg/m^3, $\bar{X}$ = 0.06 mg/m^3

Refuse Truck Driver
- Inspectors respirable dust samples n= 3044, 3% > 1 mg/m^3, $\bar{X}$ = 0.6 mg/m^3
- Company respirable dust samples n= 3464, 2% > 1 mg/m^3, $\bar{X}$ = 0.4 mg/m^3
- Inspectors respirable Quartz samples n= 329, 38% > 0.1 mg/m^3, $\bar{X}$ = 0.07 mg/m^3

Published quartz exposures in US surface coal mining and surface facilities of underground coal operations in 1988-1992 for the relevant Designated Work Positions which were required by MSHA to be sampled bimonthly;

Refuse/Backfill truck driver n=244, 46% samples contained > 5% quartz, 22% > 0.1 mg/m^3
Coal Truck Driver n =28, 46% samples contained > 5% quartz, 22% > 0.1 mg/m^3 .

Additional samples outside the mandatory sampling requirements found slightly lesser exceedances for the two work activities

Refuse/Backfill truck driver n=538 45% samples contained > 5% quartz, 13% > 0.1 mg/m^3
Coal Truck Driver n =64 36% samples contained > 5% quartz, 16% > 0.1 mg/m^3.

UK - Open Cut Haul Truck Operators Exposures

During the 1990 survey of 9 open cut coal mines in the UK, 626 personal respirable dust samples were taken across 26 occupational groups.

Dumpers of Stone (95 samples)

Respirable Dust	GM 0.43,	median 0.42,	10% 0.18,	90% 1.0 mg/m^3
Respirable Quartz	GM 0.03,	median 0.03,	10% 0.005,	90% 0.105 mg/m^3

Coal Haulage (25 samples taken)

Respirable Dust	GM 0.32,	median 0.38,	10% 0.15,	90% 1.2 mg/m^3
Respirable Quartz	GM 0.01,	median 0.005,	10% 0.005,	90% 0.045 mg/m^3

Uncertainties exist when comparing results from different jurisdictions as there is often a lack of information in the publications as to factors such as the dust monitoring techniques and sampling protocol, type and % quartz in the overburden and the use of micro-control systems such as enclosed cabs with filtered air conditioning systems.

- US surface mines produce broadly similar results for respirable dust exposures and about 2X higher for respirable quartz
- UK surface mines produce broadly similar results for respirable dust exposures and broadly similar results to Singleton district for respirable quartz.

Based on the detail and quality of the Coal Services dust sampling program and the broadly similar results obtained in the UK and USA studies, the respirable dust and respirable quartz exposure estimates made for Worker-X appear to be reasonably valid.

9.3 Is there an Expectation of Pneumoconiosis in similarly employed and exposed workers

Worker-X comes is part of a group of low exposed trades yet he is at the extreme end of the pneumoconiosis progression escalator. If his medical condition were to be considered as due to the respirable dust and respirable silica exposures associated with his employment history as reviewed in Section 3, then based on the outcomes of epidemiological studies from the coal industry, we would expected a number of cases of simple CWP the other work groups from the same exposure level or greater levels of exposure.

For example in 1990, nine large and medium sized opencast sites were investigated for evidence of pneumoconiosis and other respiratory health effects associated with exposure to respirable mixed dust and quartz.

Table 3 Radiological results: distribution of median profusion of small opacities by age group

Median profusion	Age at survey (y) <25 n (%)	25–34 n (%)	35–44 n (%)	45–54 n (%)	≥55 n (%)	Total n (%)
0/0	92 (99)	292 (97)	348 (93)	267 (88)	124 (81)	1123 (92)
0/1	1 (1)	3 (1)	16 (4)	14 (5)	13 (8)	47 (4)
1/0	0 (0)	5 (2)	6 (2)	13 (4)	9 (6)	33 (3)
1/1	0 (0)	0 (0)	3 (1)	7 (2)	3 (2)	13 (1)
1/2	0 (0)	0 (0)	0 (0)	1 (0)	2 (1)	3 (0)
2/1	0 (0)	0 (0)	1 (0)	0 (0)	2 (1)	3 (0)
2/2	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
2/3	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	1 (0)
Total	93	301	375	302	153	1224

The frequency of category ≥ 1/0 radiological abnormality found in this study was 4.4% (54 cases) which is similar to the results of studies of opencast mineworkers (4%). Five cases had moderately severe profusions of pneumoconiosis (category 2) and there were two men one with category 2, who had PMF.

The ratio of category 1 to category 2 was 1:9.8, and the ratio of category 1 to PMF was 1:24.5. Therefor it could be expected that if the exposure in the Singleton district open cut mines resulted in Worker-X developing pneumoconiosis category 3/3 and PMF, then there would likely be 25 times the number of cases of category 1/0 and 10 times the number of category 2 cases present.

Such a prediction of additional cases of lesser category pneumoconiosis is contrary to Coal Services records which indicate to date that there have been no cases of category 1 or 2 in the current workforce in the Singleton coal mining district. The case of Workers-X is an outlier.

9.4 Are the Risk Estimates for Worker-X Valid?

Worker X's cumulative respirable dust and respirable quartz exposure was used to estimate his risk of pneumoconiosis, which was found to be is very low,

- Considering respirable coal dust by itself - around 1 in 10,000 for developing CWP Category 2, and 1 in 6,600 of developing PMF.
- Considering respirable quartz by itself - 1 in 500 for developing Silicosis 1/0 or higher.
- Considering a mixture of respirable coal dust and elevated respirable quartz dust, then applying the IOM [redacted] multi opencast mine model predicts ~ a 1 in 200 risk of category 2/1+ mixed dust pneumoconiosis and a risk of ~ 1 in 400 for developing PMF.

The level of estimated risk confirms the absence of other cases such as discussed in 9.3.

9.5 Are there other Aetiological Factors which Explain the Condition of Worker-X?

To get to the clinical stage of rapid onset 3/3 and PMF requires a considerably higher exposure to respirable quartz in particular in the period 10 years prior to diagnosis than that experienced during haul truck activities. For example a few months of paid or home handyman work using modern angle grinders or portable power saws on silica containing materials such as sandstone or concrete would create sufficient exposure to push someone like Worker-X over the edge into pneumoconiosis 2+ and PMF.

The diagnosis of cryptogenic fibrosis (idiopathic pulmonary fibrosis a progressive fibrosing interstitial lung disease of unknown aetiology) has been offered by radiologist Dr [redacted]. This may be possible but difficult to prove as part of the diagnostic criteria relies on exclusion of known aetiological agents such fibrosing dusts. However the fact that Worker-X was exposed to levels of coal and silica dust below that required to result in PMF, does not exclude idiopathic pulmonary fibrosis.

10. RISK CONTROLS AT THE WORKPLACES

The modern system of occupational health and safety is one of a risk based approach. The contemporary documents supplied by the Singleton mines, lay out the array of occupational health and safety risks such as dust and provide generic approaches to ways by which these risks are to be managed and controlled. How well these systems are implemented and actioned on site remains unknown as there is limited supporting documentation and only site inspections would be able to determine the effectiveness.

A review of the respirable dust and respirable quartz levels measured since 1985 show a decline particularly in the last 10 years or so to a level in almost all instances well below the regulatory exposure standard. However this is mostly likely driven by the direct involvement of the professionalism of Coal Services who conduct the statutory requirements for medical and occupational monitoring of the workforce, and in so doing enforce the application of dust controls. Another driver of dust control relates to concern and action from the local community in relation to the release of dust into the general environment, as the reduction of environmental dust also has a flow on effect in reducing occupational exposures in open cut mines.

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August 2017