Diesel exhaust management: Our journey of continuous improvement

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Protecting the health of our people

Our HSE Framework is critical to protecting the long-term health of our people

- Group Level documents
- Organisational design protocol
- Internal audit and third party assurance
- Regular reporting of lead and lag indicators to the Executive Leadership Team (ELT) and Board,
- Global Strategic Position statements and Maturity Curves
- Annual ELT KPIs tied to long term health public targets

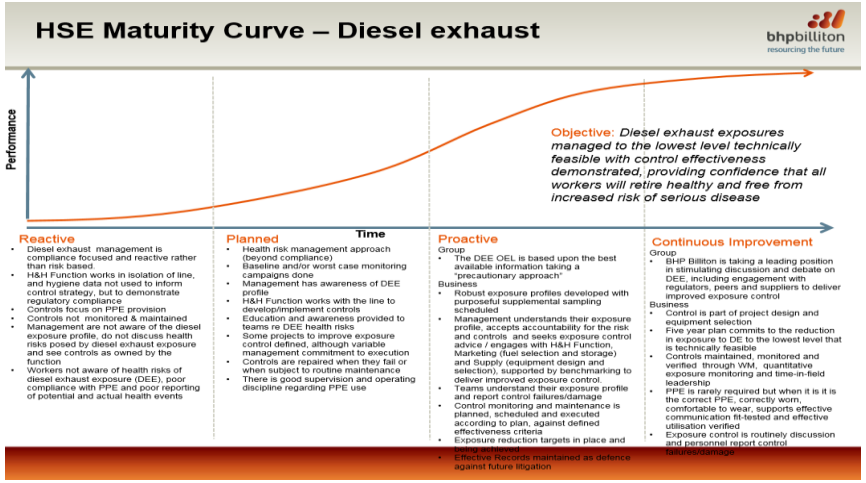
Monitor and Maintain
Incremental improvement required deliver plans
Current focus area develop plans to improve

Industry Standard - Allow others in industry to take the lead. Adopt approaches which have been piloted by other industries and peers with greater exposure.

Sector Leader - Leading position amongst the resource sector (mining, oil and gas). Recognised by others in the sector for both our commitment and performance. Influential in the sectoral policy debate.

Global Leader - Leading position within and outside our sector (mining, oil and gas). Recognised by others outside the sector as being world-leading in both our commitment and performance. Influential in the global policy debate.

	Sustainability Issue	Industry Standard	Sector Leader	Global Leader	Comments
HEALTH	Diesel Particulate Matter		⊢ - - - → ★		Higher level of risk to health requiring a significant reduction in exposure when compared with regulatory limits. Greatest level of exposure in underground mines. Global leadership to drive a step change in technology to manage exposures.
	Silica	⊢ - - - → ★			Independent review has led to a committment to reduce the OEL by 50% by 2021 Several regulatory regimes have already adopted such a level. Aim for sector leadership from a Global mining perspective. NAS is leading the sector in its management of silica.
	Noise	★			Prevention of NIHL is a priority issue by many regulators and by peer companies. Control strategies are clear.
	Mental Health	⊢ - - - → ★			Poor mental health effects 1 in 5 people in any 12 month period and 1 in 2 over a life time. A mentally healthy workforce is safer and more productive Extensive interest from regulators on FIFO and Mental Health. Visible leadership position will assist with external engagement.
	Fit for Work e.g. D&A, Fatigue	★			Other sectors have higher consequence and therefore are leaders in this field - e.g. aviation and rail. Oil and Gas Sector show greater maturity. Aligning practices with these industries provides the level of control required to protect our people.
	Health risk management (non-carcinogenic exposures, heat)	★			Prevention of potentially fatal and serious non-fatal illnesses from other exposures requires ongoing focus. Other businesses / sectors have a higher risk profile for many of these health risks. Aligning practices with these industries provides the level of control required to protect our people.



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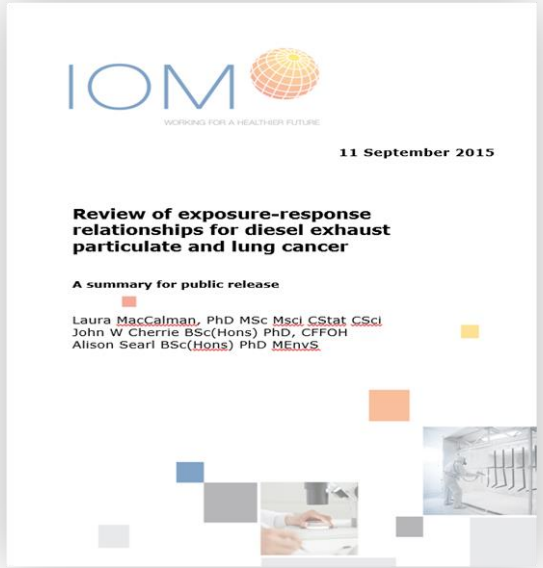
Group Level documents – setting internal occupational exposure limits

Why this is important

- Science continues to evolve but regulations lag far behind
- Default to regulatory limits would result in a material risk to our people

The process

- Continuous monitoring of the science, regulators and OEL setting bodies for our most important occupational exposures
- Annual benchmarking with Peers
- Independent expert review triggers



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Diesel OEL review process

2015 diesel exhaust OEL of 0.1 mg/m^3 (elemental carbon)

Trigger and response

- 2012 IARC classification → Original Driscoll Review → 50% rule
- 2014 Vermeulen Paper → 2nd Driscoll Review → Need for formal dose-response curves
- 2015 IOM Review → Recommended "as low as technically feasible"
- September 2015 → Adopted IOM recommendation

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The IOM analysis

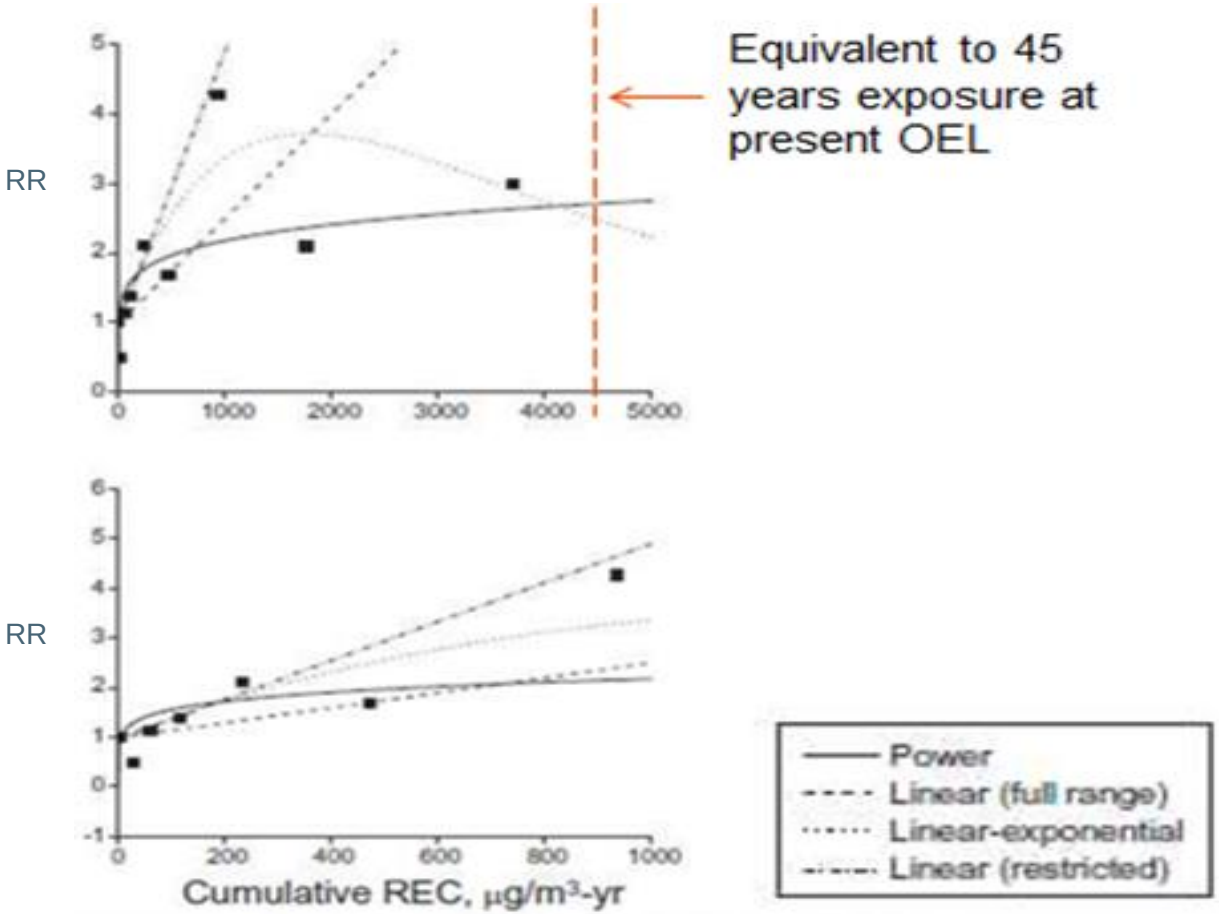

Figure 10: Exposure-response relationships derived by Silverman et al (2012) showing ORs plotted against cumulative exposure

IOM's recommended quantitative risk assessment

Exposure level (μgm^{-3})	Recommended Model (Table 24)		
	RR	95% CI	
0.1	1.2	0.98	1.35
0.3	1.2	0.99	1.36
1	1.2	1.04	1.40
3	1.3	1.18	1.53
10	1.9	1.72	2.18
30	5.6	3.78	8.14

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What are others saying

US Health Effects Institute (November 2015):

- “The Panel concluded that the data from the studies (as used by IOM) provided results and data that provide a useful basis for quantitative risk assessments of exposures in particular to older diesel engine exhaust”

Finnish Institute of Occupational Health (December 2015)

- Recommended a target OEL of 5 ug/m3 except in underground mines, where the recommendation is 20 ug/m3

US NIOSH (May 2016) – Robert Parker Lead Risk Investigator

- To present results of assessment at EPICOH conference Barcelona, September 2016. Paper under revision ahead of publication

SCOEL

- Commenced OEL risk assessment review December 2015 and due to report in December 2016

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Our Response

Current Operations:

- Main exposure risk is in underground mines. Also need to consider “fracking” and heavy vehicle maintenance workshops
- In our underground operations, we have an initial target of 0.03 milligrams per cubic metre (mg/m^3)
- All operations to report back as to what may be technically feasible
- Key challenge is lack of access to the highest tier, lowest diesel emitting engines or suitable electric substitutes

Design into potential future mines:

- In our Potash project mindset is “*eliminate diesel where feasible*”
- To date Potash have identified opportunities for 75% of underground fleet to be battery electric, with the remainder of fleet Tier 4 “Final” where available

Engage with others:

- Share information and how we are responding
- Stimulate discussion and debate

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