NSW MINERALS COUNCIL
ABN 42 002 500 316
PO BOX H367, Australia Square, NSW 1215

T 02 9274 1400
nswmining.com.au

Discussion Paper: Preventing Fires on Mobile Plant

NSW Minerals Council Submission

Executive Summary

The Resources Regulator (the Regulator) has identified fires on mobile plant as a significant hazard in the New South Wales mining industry. In particular the higher rates of such fires in surface mines and underground metaliferous mines is the focus of the Regulator's proposals for change outlined in the Discussion Paper.

Safety is the minerals industry's highest priority. NSW Minerals Council's (NSWMC) members recognise that industry and the Regulator need to closely consider what can be done to address fires on mobile plant. Industry has already commenced a proactive approach to address this issue including working closely with Original Equipment Manufacturers (OEMs), engineering design experts and maintenance personnel to identify solutions to prevent the occurrence of fire on mobile plant.

The Discussion Paper contemplates the introduction of controls utilised in the underground coal mining environment, into underground metaliferous mines and surface mines, which have a significantly higher rate of fires on mobile plant than underground coal mines. The industry is concerned that introduction of these solutions could have a significant impacts on industry, without commensurate health and safety benefits. While this appears to be a shift away from outcomes-based regulation, there may be merit in exploring the application of these controls, and others, in the underground metalliferous and surface mining environments.

The controls suggested by the Regulator, fire resistant fluids and surface temperature control, present a series of health and safety, technical and financial challenges and limitations. Alternative methods of reducing fires on mobile plant are not considered.

The Discussion Paper provides a desktop analysis of the data on mobile plant fires and the proposed solutions of use of fire-resistant fluids and surface temperature control. However, given the complex nature and potential unintended consequences of making such changes, the Regulator should undertake an extensive research and consultation program in collaboration with industry before deciding on the appropriate approach to reducing mobile plant fires.

This should include conducting detailed analysis of data to provide a better understanding of the increase in fires on mobile plant, and detailed analysis of all potential solutions. This may necessitate conducting research through bodies such as the Australian Coal Association Research Program (ACARP) and obtaining technical engineering input. Collaboration with OEMs through forums such as the Earth Moving Equipment Safety Round Table (EMESRT) will be pivotal to developing solutions to preventing fires on mobile plant.

It is important that any proposed control is feasible, technically and financially, and will result in a demonstrated improvement to health and safety outcomes. In considering what is feasible, it is important to consider the nature of the environment in which the mobile plant is operating. Risks to workers from fires underground are higher than risks of fire on surface vehicles as more people are potentially exposed to the products of fire and there is a risk of explosion from volatile gases and coal dust. It is recognised that underground coal mining takes place in a high hazard environment and corresponding

controls are utilised. The surface mining and metalliferous environments do not present the same hazards, and as such, may not warrant the same controls.

Industry members are engaged in a global research project that has been undertaken with a leading worldwide supplier of lubricants to develop a fire resistant HFDU fluid that would be suitable for use in equipment in surface mines. Current knowledge from reputable lubricant suppliers is that there is no HFDU product available that can be substituted for hydraulic mineral oil for high pressure and high temperature operating environments.

Considering the technologically unfeasible state of the controls proposed by the Regulator, industry strongly recommends that neither fire-resistant fluids nor surface temperature control be mandated. Rather than increasing safety, such mandates could create additional safety risks. However, industry recognises the importance of this issue and encourages the Regulator to continue striving for outcomes-based improvements in health and safety and looks forward to working collaboratively to investigate options to reduce the risk of fires on mobile plant.

NSWMC Comments on the Discussion Paper

The Discussion Paper focuses on surface temperature control and the use of fire-resistant fluids as strategies to mitigate fire on mobile plant. NSWMC has sought technical input from member companies to identify the key challenges associated with the adoption of surface temperature controls and fire-resistant fluids. The key issues are set out below. Appendix A contains responses to the questions asked of mine operators in the Discussion Paper.

However the controls proposed by the Discussion paper are not the only strategies or initiatives available to prevent fire on mobile plant and as discussed in this submission there are significant practical and technical hurdles to implementing these controls outside of the underground coal mine setting.

Further consideration of other methods to limit the incidents of fire on mobile equipment should be considered by the Regulator in collaboration with the industry, particularly in the light of the different circumstances of underground coal and other mining operations.

Frequency, causes, scale, hazard level and outcomes of fires on mobile plant

The figures in the Discussion Paper note that there was an average of 3.1 fires reported per month between 2001-2008, while reporting for 2018 shows an average rate of 8.4 fires per month. The Discussion Paper does not provide any analysis of the reasons for the increase. This should be the first step to understanding the problem that faces the regulator and the industry.

As a first step in a more detailed program of analysis and research, the Regulator should undertake a detailed breakdown of the incidents including an analysis of the frequencies (normalised by fleet numbers and equipment hours), causes, scale, hazard level (indicated by measures such as hydraulic oil capacity) and outcomes of incidents split across all sectors.

This will assist in understanding the hazard presented by the incidents. For example, if the fires reported are primarily small, short lived flames or embers where there is a low potential hazard and no injury, then the hazard is significantly reduced compared with a large, oil fuelled fire with a high potential hazard resulting in an injury.

This information is fundamental in conducting a detailed analysis of failure modes and causal factors that have initiated incidents.

The Regulator should consider any patterns that emerge through the analysis, including operations where fires are less frequent and interrogate how practices in those operations differ and what can be learnt from those operations about fire prevention that could be transferrable to other operations.

Alternatives strategies for preventing and mitigating fire incidents on mobile plant

The industry's highest priority is the safety of personnel. Mine operators undertake detailed risk assessment to prevent and mitigate the risks of fires on mobile plant. A range of different focus areas are considered beyond surface temperature controls and fire-resistant fluids. Examples of initiatives undertaken include implementation of engineering controls such as those contained in *MDG 15 Guideline for mobile and transportable plant for use at mines (other than underground coal mines) 2017* and *MDG41 Fluid power system safety*.

MDG 15 Guideline for mobile and transportable plant for use at mines (other than underground coal mines) 2017 was developed to improve the segregation and securing of electrical and hydraulic lines, as well as electrical circuit protection to prevent the incidence of fire whilst also improving equipment reliability. The application of this MDG regulation adds significant cost to equipment procurement and provides the benefits of reduction of fire incidents and mitigation of any fire consequences.

MDG41 Fluid power system safety has been implemented across the mining sector to increase reliability of pressure hoses through hose selection, quality assurance of hose construction and hose life monitoring and hose sheathing. The application of this MDG provides:

- Improved safety for personnel working near hoses
- Reduction in hose failures which leads to reduction in fire incidents where release of fluids is a contributing factor.

Monitoring hoses and hydraulic systems can be complex and in operational settings it can be nearly impossible to predict the failure point of a hose. Even close inspection does not always uncover potential failures. It is important that over reliance is not placed on inspection, but there is more of a focus on the manufacturer and qualitative aspects. A potential area of research for preventing fires on mobile plant is determining the predictive point at which a hose may indicate an imminent failure.

Collaborating with OEMs also provides a way in which to develop practical solutions. Mine operators have been working closely with OEMs, engineering design experts and maintenance personnel to identify solutions to prevent the occurrence of fire on mobile plant. The development of fire prevention strategies and trialling of various initiatives to fire ignition points on mobile plant (e.g installing barriers, dual skinned exhaust systems, engine turbo charger guarding/heat shields) are aimed at delivering fit for purpose solutions. Trials undertaken by mine operators of dual skinning have shown positive results to date. Such initiatives have already and will continue to result in a reduction in mobile plant fires without the need for prescriptive controls. In fact, a prescriptive approach may stifle innovative, better outcomes and cost-effective solutions.

The specific reasons and causal factors behind mobile plant fires will vary for each incident. Variations will arise between different equipment types and OEM models and operating environments. In light of this, a generalised requirement for mobile equipment as proposed in the Discussion Paper is not appropriate and mine operators support tailored solutions for the specific equipment being used, which should be considered by the Regulator.

Important differences between underground coal mines and metalliferous and surface mines not fully considered by the Regulator

The Discussion Paper does not fully consider the important differences between underground and coal mines, surface and metalliferous mines. These differences need to be investigated when considering if it is feasible or beneficial to adopt controls that are successful in underground coal mines, or whether there may be better solutions for non-underground coal mines.

The drivers for higher levels of control are different in an underground coal mine. As noted in the Discussion Paper, fires on mobile plant in underground mines can be particularly dangerous. Risks to workers from fires underground are higher than risks of fire on surface vehicles as more people are potentially exposed to the products of fire. A fire in an underground coal environment has a significant difference to other underground or surface environments due to the potential risk of explosion from ignition of volatile gas mixtures and coal dust ignition. The maintenance of surface temperature controls in underground coal applications of less than 150 degrees Celsius targets the minimum ignition temperature of some specific coal types.

By contrast, in the surface mine context, mobile equipment has on board early detection and fire suppression systems. These improvements, installed on all mobile plant, allow safe and orderly egress from equipment and reduce fire incident risk to operators and other workers.

The mobile plant used underground compared to that used on the surface is different in scale. Underground equipment typically has less than 300 HP capacity compared to surface engines of up to over 4,000 HP capacity. The scale of surface equipment results in significantly different financial implications for the implementation of the proposed controls and adds complexity, engine risks and maintainability issues.

In addition, surface mining applications have some unique features not encountered in other hydraulic systems. Due to weight and space constraints lubricant storage capacity on mining equipment is limited. Pressures and duty cycles are also often quite high. As a result fluid turnover rates and operating temperatures are also higher than in many other applications. This makes surface mining equipment a more arduous application for lubricants and caution needs to be exercised when translating experience in other industries to mining applications.

In light of the different risks and mobile plant involved in underground coal mines compared to metalliferous mines and surface mines, it is not appropriate to simply adopt the underground coal mine requirements across the board without further analysis of feasibility, effectiveness and proportionality.

The different environments have different hazards and hence different consequences are applicable to each, requiring a different level of controls. Applying the underground coal requirements across the board would have significant impact on the viability of projects and result in some projects no longer being feasible. It is important that the Regulator work with the industry to understand the costs and benefits of proposed solutions.

Impact on safety and performance of the Regulator's proposed controls

A number of major OEMs have limited lubricant approvals and in most cases the use of fire resistant-fluids would not be supported by these OEMs for use in current large mining equipment. Breaching OEM recommendations has impacts on warranties and potential safety and financial impacts.

Mining OEMs have not tested componentry while substituting HFDU for mineral oil, and component life will need to be validated if equipment is to operate with changed fluid specification. The use of fire-resistant fluids not approved by OEMs also poses performance and safety concerns, including braking, steering and hydraulic hoist systems under performance or failure.

Water/emulsion aqueous type fluids such as HFAS, HFAE, HFB and HFC should not operate above 65 degrees Celsius due to high vapour pressures and potential evaporative loss. This alone limits their applicability as many mobile hydraulic systems currently run well in excess of this temperature. At temperatures above 100 degrees Celsius water/emulsion aqueous type fluids HFAS, HFAE, HFB and HFC exhibit rapid increases in acidity and varnish potential. These varnish deposits are extremely detrimental to the control systems, valves and actuators and rapidly diminish machine performance. Aqueous based fluids require de-rating of the system making them less practical for use in mobile equipment.

Of the remaining fire-resistant fluids, HFDR fluids are the most fire resistant, however they are incompatible with nitrile seals/hoses meaning that they are not suitable for use in most existing mobile fleet systems. In addition there is also ongoing discussion on the toxicity of fumes from phosphate esters that would need to be considered.

As highlighted in the Discussion Paper, HFDU is 400% to 500% times more expensive than mineral oil. As an example of the potential cost implications, one mine operator estimated that the usage across their NSW operations is 1.5 million litres of hydraulic oil each year. Whilst there are claims that extended life may be achieved, that can only occur where the fluid is not contaminated or lost due to hose or other failures. As a result, the offset of any extended life to the increased cost incurred will not be a direct relationship.

In addition to increased running costs, there would be a significant financial impost in transitioning to fire-resistant fluids as mineral oil and HFDU fluids are not compatible. The transition would require equipment to be hydraulically disassembled to flush out the mineral oil. Premature failures are a likely outcome of any transition to HFDU oils. The consequences of using HFDU that is not suitable are failures that could cost in the range of hundreds of thousands of dollars for a single machine, and cumulatively millions of dollars over fleets of equipment.

Industry members are engaged in a global research project that has been undertaken with a leading worldwide supplier of lubricants to develop a fire resistant HFDU fluid that would be suitable for use in

equipment on surface mines. Current knowledge from reputable lubricant suppliers is that there is no HFDU product available that can be substituted for hydraulic mineral oil for high pressure and high temperature operating environments.

Furthermore, as noted in the Discussion Paper there was only one fire incident in the underground coal sector in 2017. Mineral oil is used in equipment for the underground coal sector hence this highlights that the use of mineral oil is not causative of fires occurring on mobile plant. Any changes requiring the use of fire-resistant fluids would not have a tangible effect on safety.

Considering the above circumstances, mandating the use of HFDU is not technologically viable and NSWMC strongly recommends against it. There are no suitable products available, development time is unknown and it is not a commercially viable alternative.

Unintended consequences of the Regulator's proposed approach

There is presently limited or no available information on the effects of a proposed regulated approach on surface temperature controls and fire-resistant fluids. It is important that an evaluation of commercial competitiveness, equipment suitability, equipment availability, cost-benefit analysis and adverse, unintended consequences of control solutions be undertaken.

Adverse, unintended consequences of control solutions as proposed control measures are hypothetical and have not been tested and verified on equipment of this capacity and in operating environments. The resulting effects of these measures are not known but may include increased equipment weight impacts, changes to engine emissions, increased cooling package loading, increase in sound attenuation requirements, increase in maintenance requirements, increased reliability issues and increased or new personnel safety hazards.

There is considerable risk in drawing comparisons of technologies from other industry and environments and proposing them without any validation. This would significantly increase costs and could create unacceptable risks.

Conclusion and Recommendations

In light of the complexities in the ability to adopt surface temperature controls and the use of fire-resistant fluids a blanket regulatory approach to preventing fires on mobile plant is strongly not recommended. Rather than increase safety, implementing such requirement could create additional safety risks.

It is recommended that further analysis and work is undertaken with OEMs and mine operators to understand the causes of mobile plant fires and explore effective and practical solutions.

Detailed engineering input should be gathered through research bodies such as Australian Coal Association Research Program (ACARP). Forums such as the Earth Moving Equipment Safety Round Table (EMESRT) would be useful in progressing the prevention of fires on mobile plant. EMESRT involves member companies engaging with key mining industry OEMs to advance the design of equipment to improve safe operability and maintainability beyond Standards.

NSWMC appreciates the opportunity to provide feedback on the Discussion Paper and welcomes future involvement in any further development of this initiative. For information regarding our submission, please contact James Barben, Director Policy, on 02 9274 1431 or jbarben@nswmining.com.au.

Appendix A

Are you currently using HFDU in mining plant?

Mine operators are not currently using HFDU in mining plant.

Are you currently using fire-resistant coolant?

Mine operators are not currently using fire-resistant coolant.

Whilst coolant is flammable is certain circumstances, the risk to people and assets is minimal and managed by the on-board fire suppression systems or hand-held fire extinguishers.

Are you using any other fire-resistant fluids?

Other fire-resistant fluids used include using:

- HFD-U oil
- Tap water with Donaldson coolant tablets instead of coolant in some heavy vehicles.

Why did you make the change or why haven't you made the change to fire-resistant fluids?

Reasons the change to fire-resistant fluids has not been made include:

- The cost of HFDU is up to 5 times greater than mineral based oils. Whilst there are claims that extended life may be achieved that can only occur where the fluid is not contaminated or lost due to hose or other failures. As a result the offset of any extended life to the increased cost incurred will not be a direct relationship.
- The equipment used in open cut mining has far more complex hydraulic circuits with larger volumes, greater flows and duty cycles. The impact HFDU oil has on component life in hydraulic excavators is currently unknown.
- OEM recommendations and warranty concerns. Failure to follow OEM recommendations can void warranties for equipment of significant value. A number of major OEMs have limited lubricant approvals and in most cases the use of fire-resistant fluids would not be supported by these OEMs for use in current large mining equipment.
- Performance concerns, with using lesser product. This is a safety and asset concern, which can create other performance-based risks including braking, steering and hydraulic hoist systems under performance.
- Inadequate real time study and evidence basis to utilise in change and risk assessment process.
- Focusing on other fire prevention areas. Fire is better controlled eliminating sources, from suppression and maintenance practices. Significant time and resources has been invested on fire prevention, including robust hose replacement and monitoring regimes.
- Water/emulsion aqueous type fluids such as HFAS, HFAE, HFB and HFC should not operate above 65 degrees Celsius due to high vapour pressures and potential evaporative loss. Of the remaining fire-resistant fluids, HFDR fluids are the most fire resistant, however they are incompatible with nitrile seals/hoses meaning that they are not suitable for use in most existing mobile fleet systems.

What are the barriers to introducing fire-resistant fluids for mobile plant on mines?

Barriers to introducing fire-resistant fluids for mobile plant on mines include:

- Potential detrimental health and safety impacts such as equipment failure and fumes
- Cost
- Equipment requirements and compatibility. Equipment is not designed to utilise fire-resistant fluids and would need to undergo major engineering design changes and component changes by the OEM to achieve this.
- Lack of supply available
- Lack of vendor options

If you have switched to HFDU, in some or all mobile plant, what was your experience in switching from mineral oil to HFDU or other substitutions that have been made.

- **Were there any issues with components, brakes, changes to the operations or safety of the plant?**
  - Component failures occur due to the incompatibility of additive packs in the oils. This causes the additives to drop out of the oil reducing the lubrication effect of the oil.
- **Was cost a factor?**
  - Are there additional costs associated with changeover and ongoing maintenance?

    Failure, flushing of fluids and disposal of hydrocarbon based oils. There are also concerns around supply continuity during the transition period if HFDU oils were to be mandated in open cut operations.
  - What is the cost of HFDU in comparison to mineral oil?

    4 to 5 times the cost with no history available on oil life comparison.
- **Has the use of HFDU in mobile plants resulted in increased or decreased reliability of the plant?**

  Not applicable
- **Were there any unintended consequences or new risks related to the introduction of fire-resistant fuels?**

  Not applicable

What other fire reduction strategies do you have in place or are you considering implementing such as:

- **Water jacketing**
  - Adoption of strategies would require a cost benefit analysis to be undertaken. Currently water jacketing is not available with engineering and manufacture being far too expensive for no benefit. The water jacket exhaust would potentially create a failure point for the engine, with the risk of failure of a 300T haul truck engine being $750,000.
  - The volume of water required for cooling to circulate through additional radiators would be extremely large and the radiators would be a size that would make them difficult to mount on most equipment.

The addition of further weight to equipment also reduces payload and adds significant cost to the operation and productivity of fleet.

- **Other surface temperature control methods**
  - Installing dual skin exhausts on engine with greater than 1000 hp and (where space allows) on equipment such as excavators and haul trucks. Recommend aligning the installation at the engine change out, based on current engine life this would be 3 years on excavators and up to 6 years on haul trucks.
  - Blankets to cover manifolds.
  - Turbo lagging.
  - Ceramic exhaust coatings, textile lagging or OEM heat shielding.

- **Segregation improvements**
  - Consideration is being given to sheaving of fuel and hydraulic hoses in the engine bay of smaller units such as dozers and small loaders.
  - Segregation of electrical harnesses and metal fuel/oil hoses.
  - Improved support and separation of known high risk hoses.

- **Maintenance improvements**
  - In conjunction with dual skin exhaust, consideration should be given to time-based thermography inspections to identify and manage potential flash points on the equipment.
  - Guidance on fire suppression system requirements would be useful. e.g. loss of pressure activation AFFF systems verses rise of pressure activation or fog maker systems.

- **Other**
  - Lagging of hot exhaust parts in engine bays (including turbos).
  - Detailed equipment maintenance strategies (inclusive of daily inspections).
  - Industry best practice on site oil analysis to predict component failures, subsequently reducing the risk of oil contacting hot surfaces.
  - Time based preventative hydraulic and fuel line change outs for hoses at risk of spraying oil/fuel on the hot side of the engine in the event the hose bursts.
  - Burst protection/flame retardant sheathing of specific high-risk hoses.
  - Improved support and separation of known high risk hoses.
  - Upgraded fuel system hardware including double braided fuel lines, fire resistant housings and hardware (steel or glass).
  - Relocation of header tanks on Volvo ITs to remove the risk of coolant contacting exhaust lagging.