NSW GOVERNMENT

NSW Resources Regulator

# FIRES ON MOBILE PLANT

April – June 2021

NSW Resources Regulator

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# Contents

# Overview

## In FY 2021 Q4, there were:

**NOTIFIED INCIDENTS**
**47**
DECREASE OF 5 FROM 52 Q3 FY 2021

- **36** Surface coal (77%)
- **5** Underground metals (11%)
- **3** Surface metals (6%)
- **2** Construction materials (4%)
- **1** Underground coal (2%)

## Incidents classified against a material unwanted event (MUE) - fire or explosion

| MUE | | Most common threat with failed critical control | | Most common failed critical control |
|---|---|---|---|---|
| **Surface** 44 | 20 of 44 | Accumulated flammable leaks and spills | 20 of 44 | Flammable fluid containment |
| **Underground** 3 | 2 of 3 | Electrical energy in the presence of fuel | 2 of 3 | Electrical protection |

## Ancillary reports summary

- Heat source **34%** EXHAUST SYSTEM
- Fuel source **30%** ENGINE OIL
- Failed component **19%** HOSE
- Extinguished by **43%** HAND-HELD FIRE EXTINGUISHER

NSW Resources Regulator

# Executive summary

This report has been prepared by the NSW Resources Regulator for the NSW mining industry, original equipment manufacturers and suppliers. It contains quarterly data of notified incidents involving fires on mobile plant (FOMP) between 1 April 2021 and 30 June 2021.

The Regulator's position is that all fires on mobile plant are avoidable and preventable and we have adopted a zero-tolerance approach where mine operators have not taken appropriate steps to manage this risk.

Fires on mobile plant are inherently dangerous. They affect the safety of workers and have potentially catastrophic consequences. Despite a focus on the issues in recent years, the number of incidents remains high. The Regulator is committed to working with industry to ensure health and safety obligations are being met to reduce the number of fires on mobile plant and to prevent potentially catastrophic events.

Quarterly data for 1 April 2021 to 30 June 2021 identified the following:

- This quarter shows a slight decline in the number of fires on mobile plant, with the number of notified incidents remaining relatively stable since February 2020.
- There were three notifiable incidents at mines categorised as surface metals this quarter, the highest number per quarter for this category since FY 2020 Q3.
- There has been a gradual increase in mechanically generated heat being listed as the threat line in FOMP incidents occurring at the surface, with 17 incidents this quarter.
- The most common combination of heat source and fuel source this quarter was exhaust systems with engine oil, accounting for seven out of 47 FOMP incidents.

# Emerging trends and recommendations

Throughout this reporting period, the following was identified as an ongoing and or emerging trend.

1. Hose failures due to poor installation, routing, and segregation.
2. Early life failure of turbo.
3. Starter motor failures.
4. Poor installation of components.

## Recommendations

**1. Hose failures**

Effective control measures should be applied to management of hoses to include:

- All pipes and hoses should be routed and supported in a manner that will give them maximum mechanical protection against wear and damage.
- All pipes and hoses should be adequately segregated to prevent rubbing.
- Shielding should be installed between pipes/hoses and any adjacent components that have operating surface temperatures more than 150 degrees Celsius. For example, fire walls, lagging, deflective guards etc.
- Installation drawings are to provided/made available to workers.
- Inspections of all hose are to be included in maintenance and inspection regimes.
- Maintenance strategies for the replacement of hoses will take into consideration the risks associated with their failure to the health and safety of workers based on the hose location. This should include the risk to workers both directly (fluid injection) and indirectly (fire).
- The replacement strategy for hose replacement should include considerations for any recommendations from manufacturers and the analysis of data from past failures.
- Training of workers who are installing and inspecting hose assemblies on what to look for, replacement criteria and correct methods of installation.

A number of the above issues are similar in nature as contained within the mining design guideline (MDG 41) Fluid power safety systems at mines.

Mine operators should also review the times allocated for inspecting hoses to allow workers sufficient time to carry out inspections.

**2. Early life failure of turbo**

Mine operators should review the following:

- The components replaced when overhauling turbos. The overhaul strategy should consider manufacturer's recommendations and the analysis of data from past failures.

- The quality assurance checks undertaken as part of the overhaul to include acceptance criteria.

3. **Starter motor failures**

   Mine operators should review and update the maintenance replacement strategy as required. Replacement strategy should consider manufacturer's recommendations and the analysis of data from past failures.

4. **Poor installation of components.**

   Mine operators should review the following:

   - The training and competence of workers in relation to the work they are undertaking.
   - The supervision of workers.
   - Time frames allocated to tasks to ensure enough time has been allocated.
   - The handover information provided to workers when activities are being conducted over multiple shifts.
   - Work order information/instruction provided to workers. This information should include all the relevant information to carry out the tasks being performed. For example, but not limited to the torque requirements for components, installation procedures or instruction, drawings /schematics, extract from manufacturer's manuals, commissioning checks.
   - The reuse of previously torqued bolts. Bolts that are required to be torqued should be replaced in accordance with manufacturer's recommendations.
   - The checks carried out before returning equipment to service after maintenance.

# Notified incidents

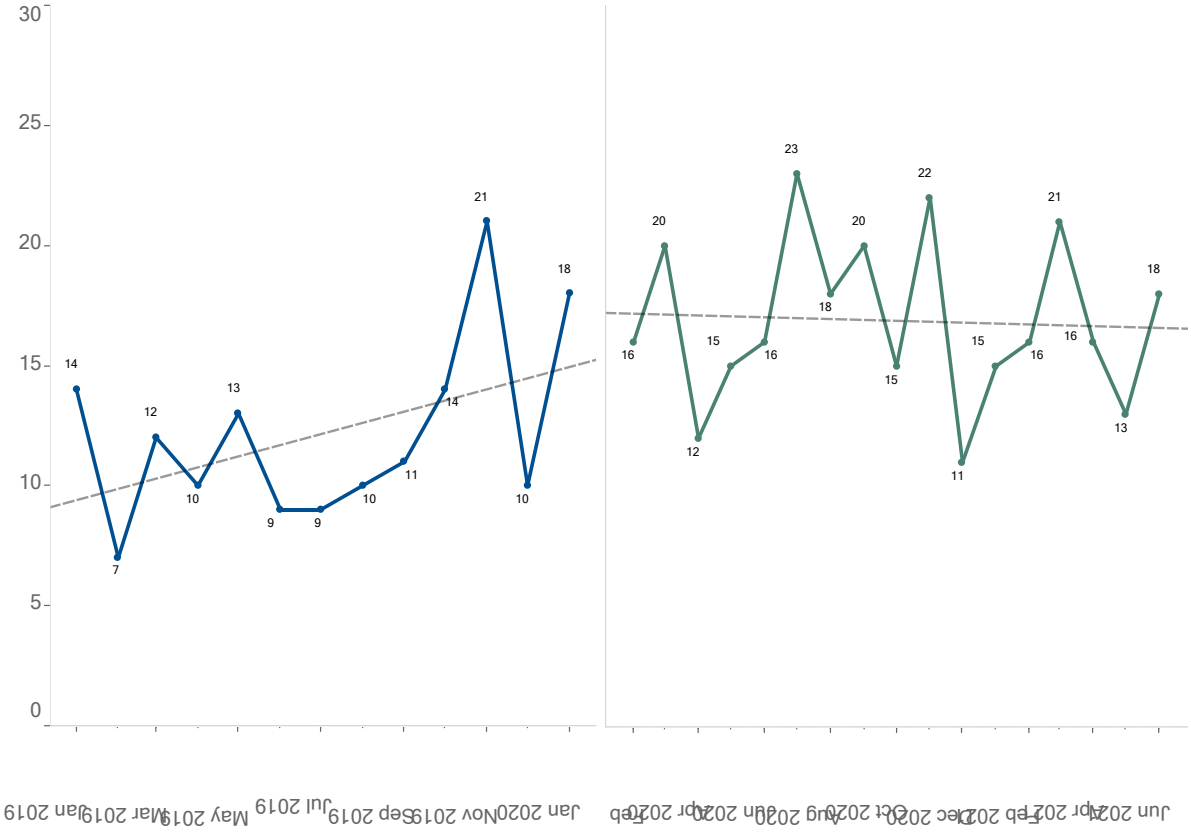
## Notified incidents between January 2019 and June 2021

The chart below relates to incidents involving fires on mobile plant notified to the Regulator each month since January 2019, based on the date the incident occurred.

In February 2020, amendments to the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 saw a change to the duty to notify all incidents involving fires on mobile plant (see Annexure A). The two trend graphs below represent the periods before and after this amendment took place.

While notifications in June 2021 were up five from 13 in May, an overall slight decline in notifications can be seen since the legislation was amended in February 2020.

*Figure 1: Notified incidents between 1 January 2019 and 30 June 2021*



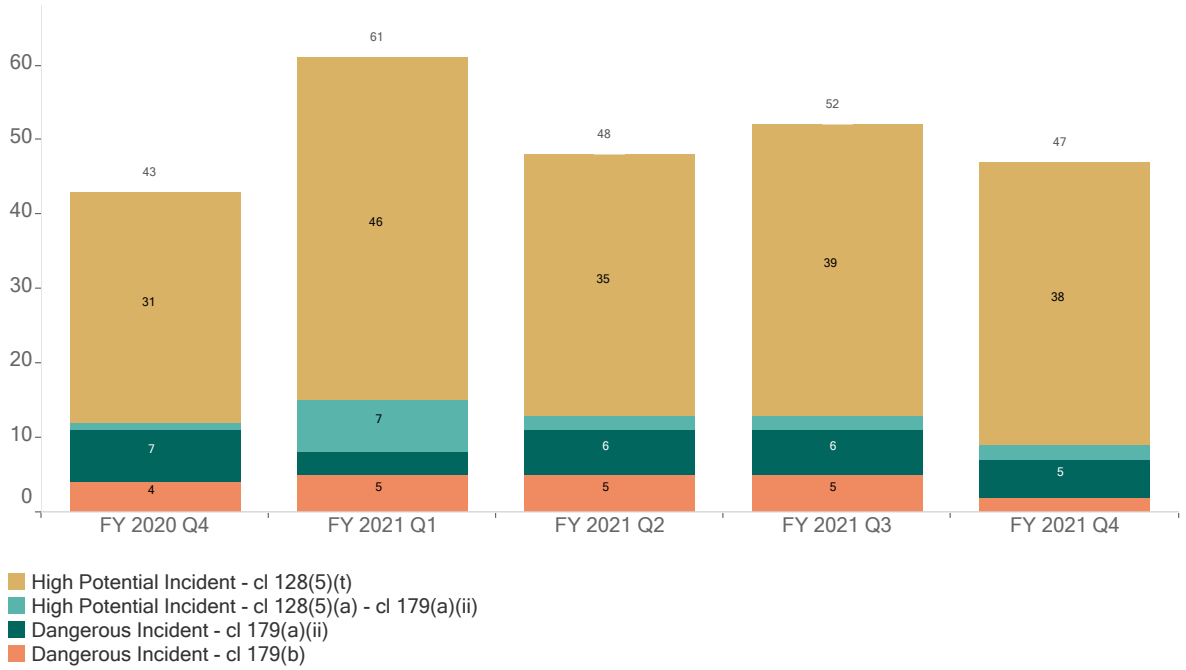
# Notified incidents by legislative requirement to report

The chart below highlights the number of notified incidents recorded by the legislative requirement to report.

The majority of fires on mobile plant notified to the Regulator since 1 April 2020 were recorded as a high potential incident under cl 128(5)(t), where there was 'an uncontrolled fire on mobile plant that is in operations (whether operated directly, remotely or autonomously)'.

Five incidents were recorded this quarter as a dangerous incident under cl 179(a)(ii) where there was 'an uncontrolled implosion, explosion or fire'.

*Figure 2: Notified incidents by legislative requirement to report between 1 April 2020 and 30 June 2021*



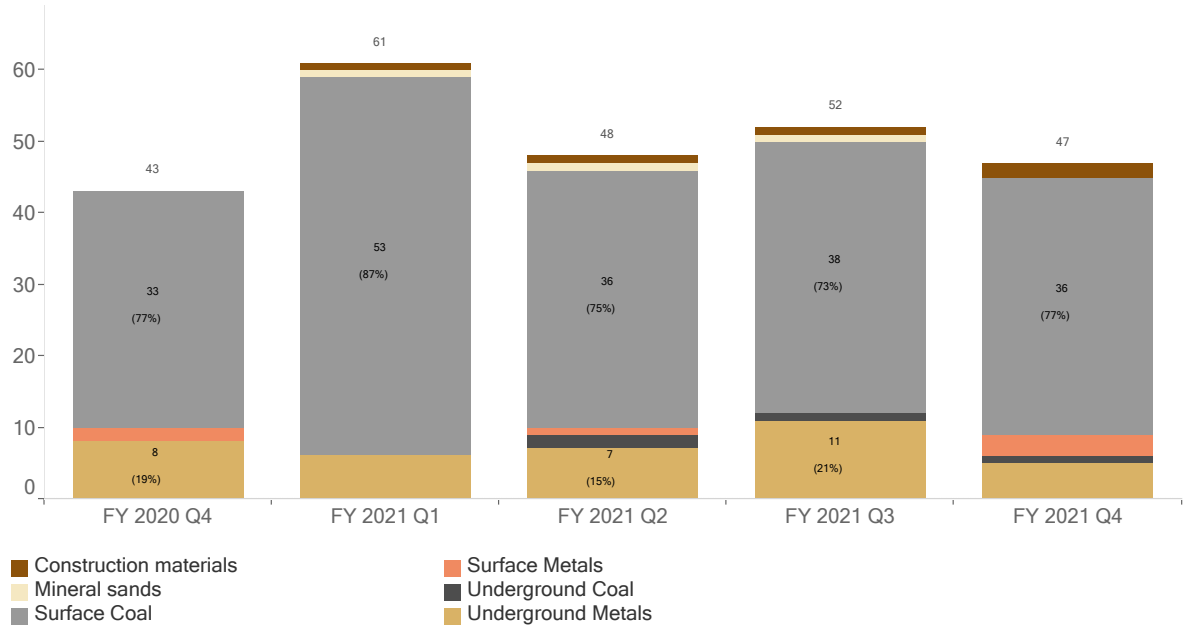
# Notified incidents by mine and operation type

The chart below shows the number of notified incidents by mine type and operation type.

Surface coal still has the highest number of notified incidents, with 77% of notified incidents for this quarter.

There was an increase in notified incidents occurring at mines categorised as surface metals, from zero notifiable incidents in FY 2021 Q3 to three notifiable incidents this quarter.

*Figure 3: Notified incidents by mine and operation type between 1 April 2020 and 30 June 2021*

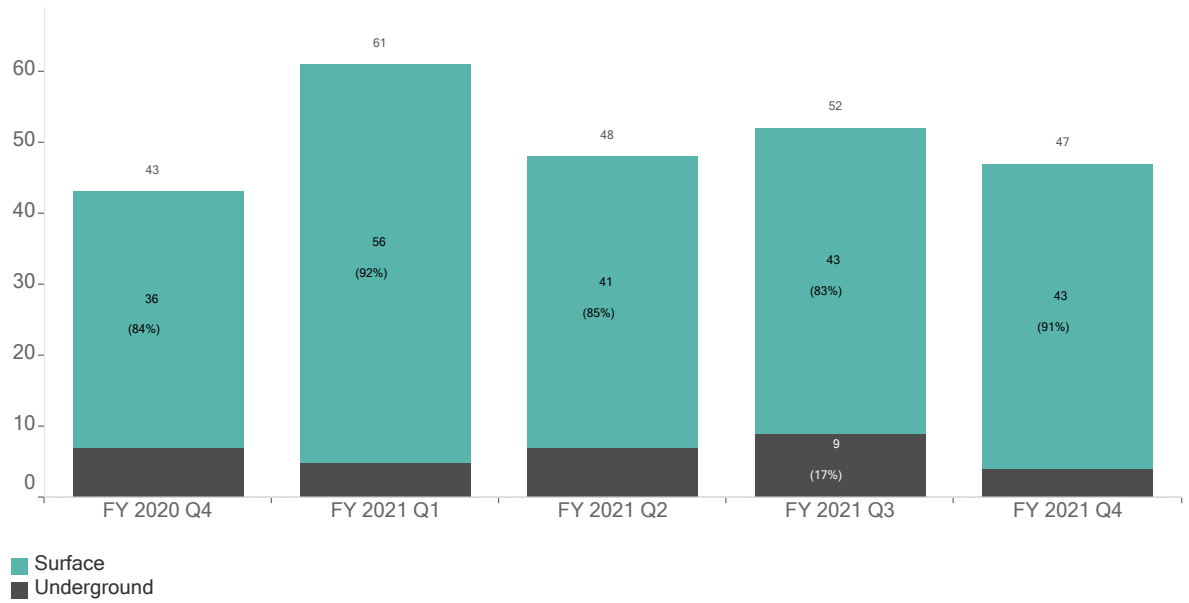


# Notified incidents by primary location

The figure below shows that the actual location of FOMP incidents, irrespective of the mine operation type, typically occurs on the surface rather than underground. For the past five quarters the proportion of mobile plant fires occurring at the surface has been 80% or higher.

There were four notified incidents this quarter that occurred underground, which is a reduction by five from nine incidents last quarter. This is the lowest number of mobile plant fires occurring underground for the past five quarters.

*Figure 4: Notified incidents by primary location between 1 April 2020 and 30 June 2021*



# Notified incidents by mine type, operation type and incident location

Notified incidents occurring on the surface at a surface coal mine account for 77% of all fires on mobile plant this quarter.

*Table 1: Notified incidents by mine type, operation type and incident location between 1 April 2020 and 30 June 2021*

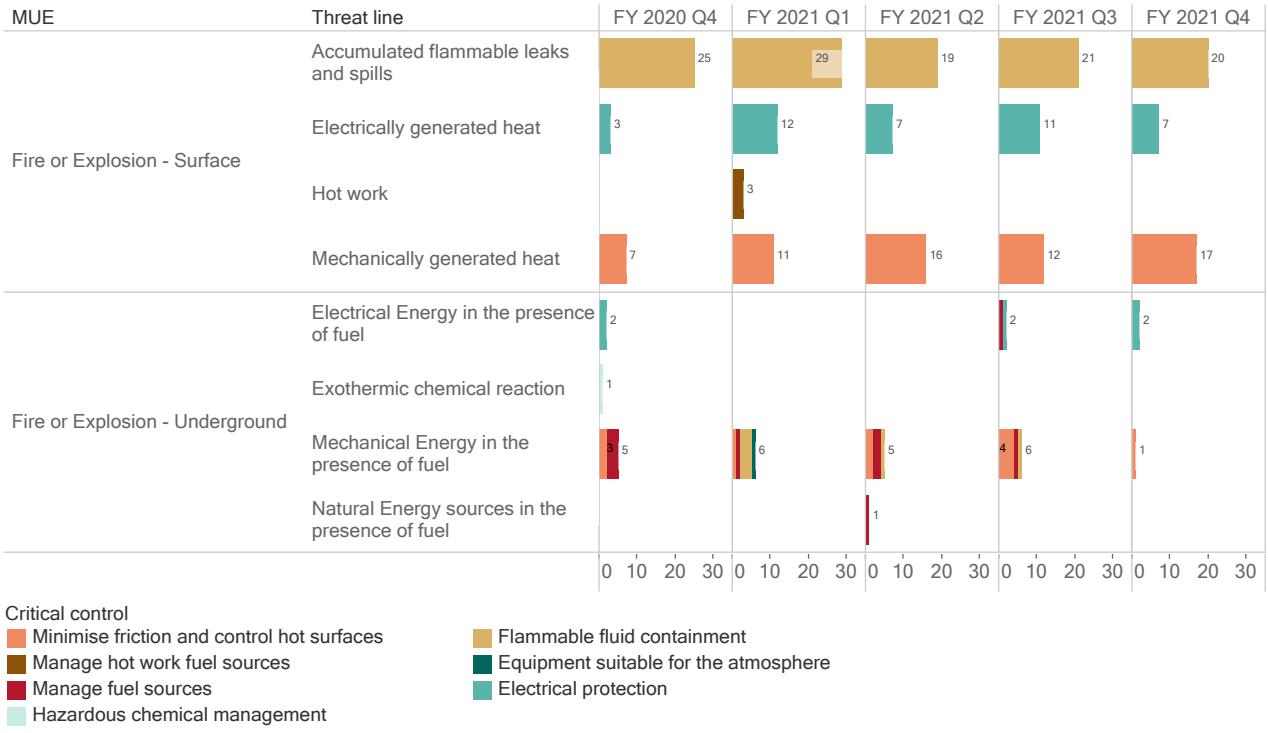
| MINE TYPE / OPERATION TYPE / INCIDENT LOCATION | FY 2020 Q4 | FY 2021 Q1 | FY 2021 Q2 | FY 2021 Q3 | FY 2021 Q4 | GRAND TOTAL |
|---|---|---|---|---|---|---|
| **Coal / surface / surface** | 33 | 53 | 36 | 38 | 36 | **196** |
| **Coal / underground / surface** | -- | -- | 1 | 1 | 1 | **3** |
| **Coal / underground / underground** | -- | -- | 1 | -- | -- | **1** |
| **Metals / surface / surface** | 2 | -- | 1 | -- | 3 | **6** |
| **Metals / underground / surface** | 1 | 1 | 1 | 2 | 1 | **6** |
| **Metals / underground / underground** | 7 | 5 | 6 | 9 | 4 | **31** |
| **Mineral sands / surface / surface** | -- | 1 | 1 | 1 | | **3** |
| **Construction materials / surface / surface** | -- | 1 | 1 | 1 | 2 | **5** |
| **Grand total** | **43** | **61** | **48** | **52** | **47** | **251** |

# Classified notified incidents by hazard, threat and critical control

Hazard management bowties are a widely used risk management tool that incorporate preventative and mitigating controls onto threat lines that relate to a material unwanted event (MUE). The Regulator uses MUE bowtie frameworks when proactively assessing how mine sites manage their principal hazards and, since October 2019, these MUE bowtie frameworks have also been used to classify notified incidents. Classifications highlight increased areas of risk at the hazard, MUE, threat and critical control level.

The chart below shows notified incidents classified by MUE, threat and critical control.

*Figure 5: Notified incidents by MUE, threat and critical control between 1 April 2020 and 30 June 2021*

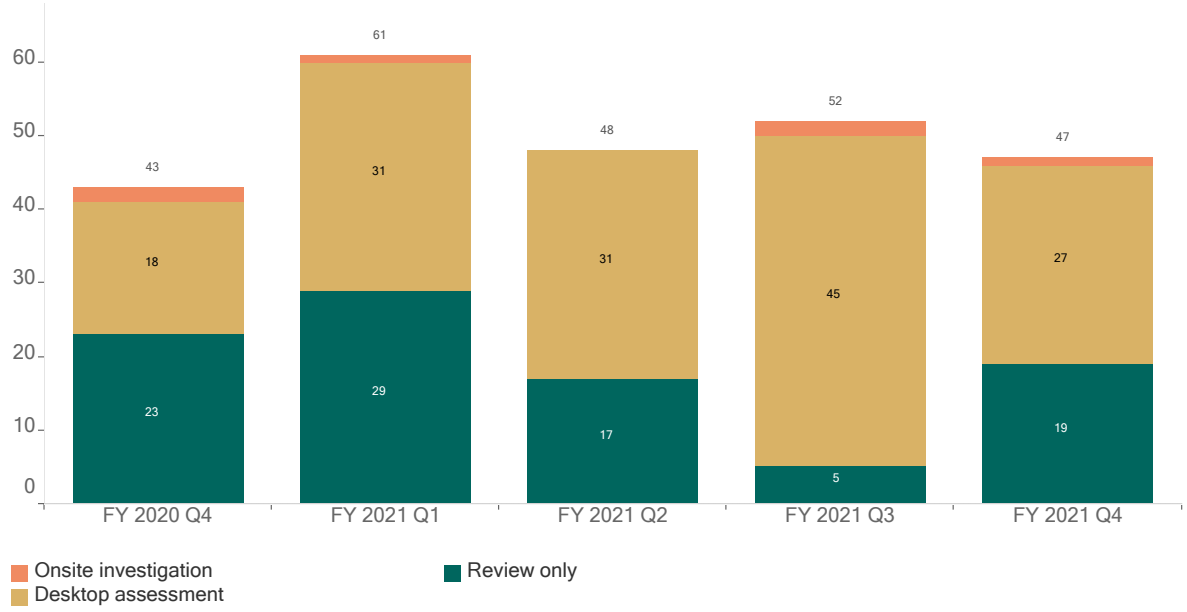


# Our response to notified incidents involving FOMP

As part of the Regulator's position paper on preventing fires on mobile plant, all fires that occur on mobile plant are preventable. For each incident reported, it was assessed and the outcomes reviewed. This involved an inspector attending the mine (onsite investigation) or a review of the investigation findings and actions (desktop assessment).

The chart below shows that for this quarter there was one onsite investigation conducted in response to notified incidents involving fires on mobile plant. The number of desktop assessments conducted has reduced this quarter from 45 to 27, representing a 40% decrease. Reviews of FOMP incidents have increased from five reviews to 19 reviews.

*Figure 6: Notified incidents by response level between 1 April 2020 and 30 June 2021*



# Fires on mobile plant ancillary reports

When an incident involving fires on mobile plant is notified to the Regulator, additional information, known as an ancillary report, must be submitted via the Regulator Portal no later than 30 days after the incident was required to be notified.

## Ancillary reports – combination heat/fuel sources

Data for heat sources and fuel sources for FOMP notifiable incidents this quarter indicate that the exhaust system heat source category and engine oil fuel source category combined for seven out of 47 incidents (15%). The second most common combination this quarter was electrical component and electrical wiring, accounting for six out of 47 incidents (13%).

*Figure 7: Ancillary reports - fuel sources combined with heat sources, between 1 April 2021 and 30 June 2021*

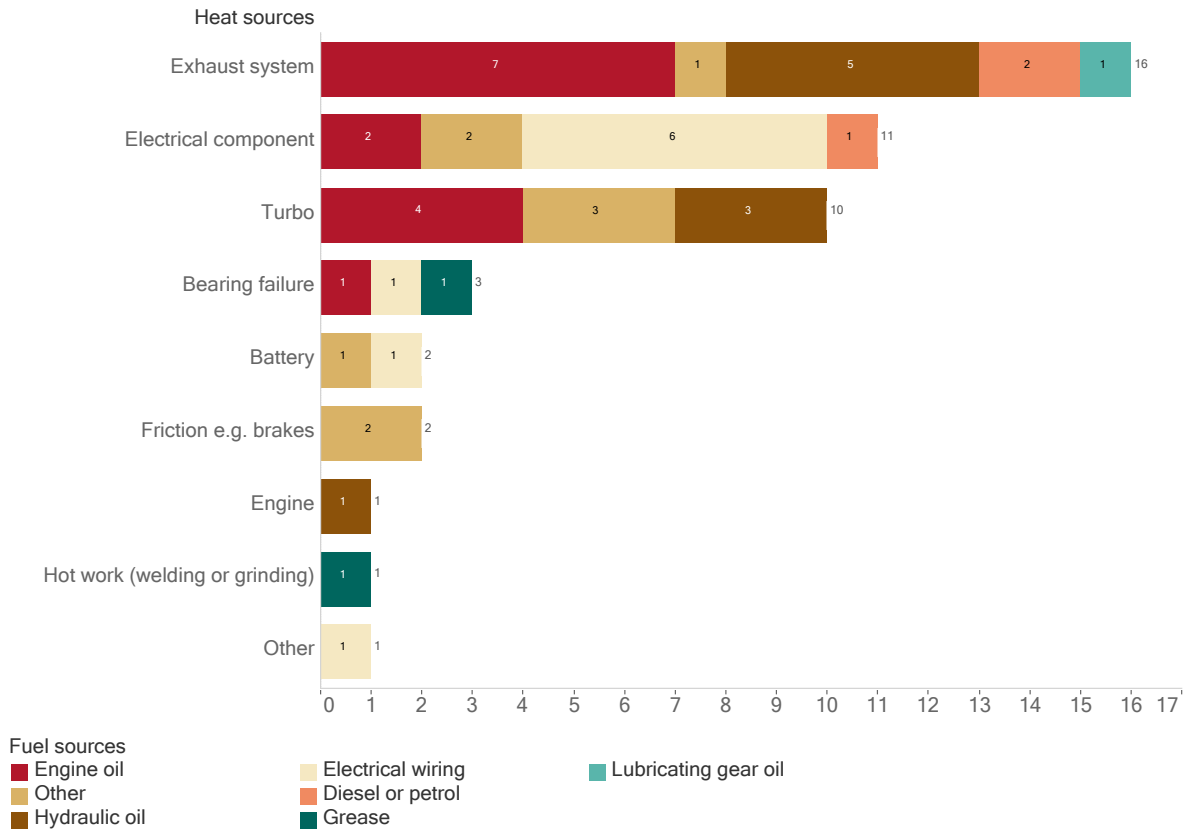


*Table 2: Ancillary reports – fuel sources combined with heat sources, between 1 April 2020 and 30 June 2021*[1]

| HEAT SOURCE + FUEL SOURCE | FY 2020 Q4 | FY 2021 Q1 | FY 2021 Q2 | FY 2021 Q3 | FY 2021 Q4 | GRAND TOTAL |
|---|---|---|---|---|---|---|
| **Turbo + engine oil** | 3 | 10 | 8 | 8 | 4 | **33** |
| **Exhaust system + hydraulic oil** | 9 | 8 | 4 | 3 | 5 | **29** |
| **Electrical component + electrical wiring** | 2 | 7 | 6 | 6 | 6 | **27** |
| **Turbo + hydraulic oil** | 6 | 6 | 3 | 4 | 3 | **22** |
| **Exhaust system + engine oil** | 5 | 3 | 3 | 2 | 7 | **20** |
| **Turbo + other** | 2 | 2 | 1 | 4 | 3 | **12** |
| **Exhaust system + diesel or petrol** | 1 | 4 | | 3 | 2 | **10** |

[1] 10 or more incidents since 1 April 2020

# Ancillary reports – extinguished by

The charts below show that a hand-held fire extinguisher remains one of the highest recorded methods of extinguishment. The second highest method of extinguishment this quarter was recorded as a manually deployed fire protection system, recorded in 11 notified incidents of fire on mobile plant.

*Figure 8: Ancillary reports - extinguished by, between 1 April 2021 and 30 June 2021*

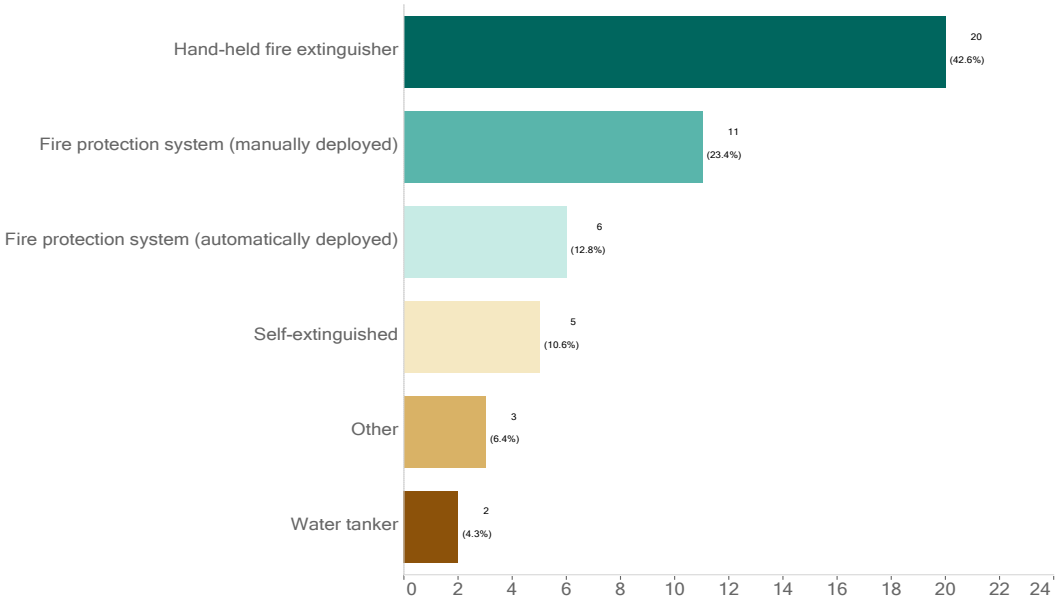



*Table 3: Ancillary reports – extinguished by, between 1 April 2020 and 30 June 2021*

| EXTINGUISHED BY | FY 2020 Q4 | FY 2021 Q1 | FY 2021 Q2 | FY 2021 Q3 | FY 2021 Q4 | GRAND TOTAL |
|---|---|---|---|---|---|---|
| **Hand-held fire extinguisher** | 17 | 26 | 17 | 21 | 20 | **101** |
| **Fire protection system (manually deployed)** | 11 | 12 | 17 | 15 | 11 | **66** |
| **Self-extinguished** | 7 | 3 | 5 | 5 | 5 | **25** |
| **Fire protection system (automatically deployed)** | 4 | 6 | 4 | 3 | 6 | **23** |
| **Other** | 2 | 7 | 1 | 3 | 3 | **16** |
| **Water tanker** | 1 | 3 | 4 | 4 | 2 | **14** |
| **N/A** | -- | 3 | -- | -- | -- | **3** |
| **Did not extinguish** | 1 | -- | -- | 1 | -- | **2** |

# Ancillary reports - failed component

There has been a reduction this quarter in notified incidents occurring where the hose was listed as the failed component (from 14 to nine) however the hose was the most common single failed component.

The category of 'other' as a failed component has increased from five incidents last quarter to nine incidents this quarter. The Regulator is conducting a review of incidents in which the failed component is listed as 'other' in an effort to reduce FOMP incident notifications with this category in future.

*Figure 9: Ancillary reports - failed components, between 1 April 2021 and 30 June 2021*

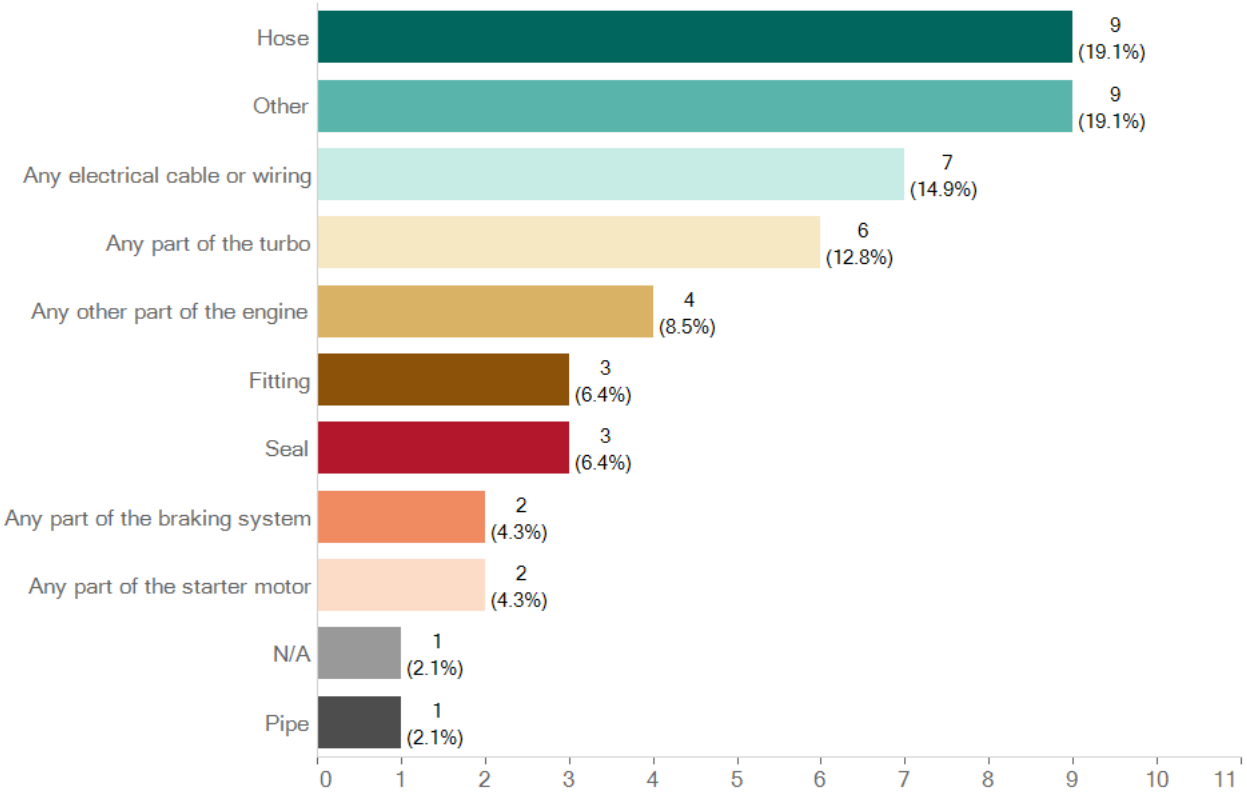


*Table 4: Ancillary reports – failed component, between 1 April 2020 and 30 June 2021*

| FAILED COMPONENT | FY 2020 Q4 | FY 2021 Q1 | FY 2021 Q2 | FY 2021 Q3 | FY 2021 Q4 | GRAND TOTAL |
|---|---|---|---|---|---|---|
| **Hose** | 10 | 13 | 9 | 14 | 9 | **55** |
| **Other** | 4 | 20 | 10 | 5 | 9 | **48** |
| **Any electrical cable or wiring** | 4 | 6 | 5 | 8 | 7 | **30** |
| **Any part of the turbo** | 5 | 8 | 6 | 5 | 6 | **30** |
| **Seal** | 6 | 4 | 2 | 5 | 3 | **20** |
| **Fitting** | 7 | 1 | 3 | 4 | 3 | **18** |
| **Any other part of the engine** | 2 | 2 | 4 | 2 | 4 | **14** |
| **Any part of the braking system** | 2 | 1 | 4 | 1 | 2 | **10** |
| **Pipe** | 1 | 2 | 2 | 3 | 1 | **9** |
| **Any part of the starter motor** | 1 | 1 | 1 | 1 | 2 | **6** |
| **Transmission or drive chain** | 1 | 2 | -- | 1 | -- | **4** |
| **Cooling system failure** | -- | -- | 1 | 2 | -- | **3** |

# Ancillary reports - combination failed component and cause of component failure

The most common combination this quarter was ‘other’ and ‘other’, with eight notified incidents out of 47 noting this combination. These categories may be recorded as ‘other’ for several reasons including human errors or uncategorised component failures. The Regulator is conducting a review of incidents in which failed components and cause of component failure were listed as ‘other’ in an effort to reduce the instances of this grouping.

Hoses being the failed component combined with wear and tear as the cause of component failure combined for four out of 47 incidents (9%).

*Figure 10: Ancillary reports - failed component and cause of component failure, between 1 April 2021 and 30 June 2021*

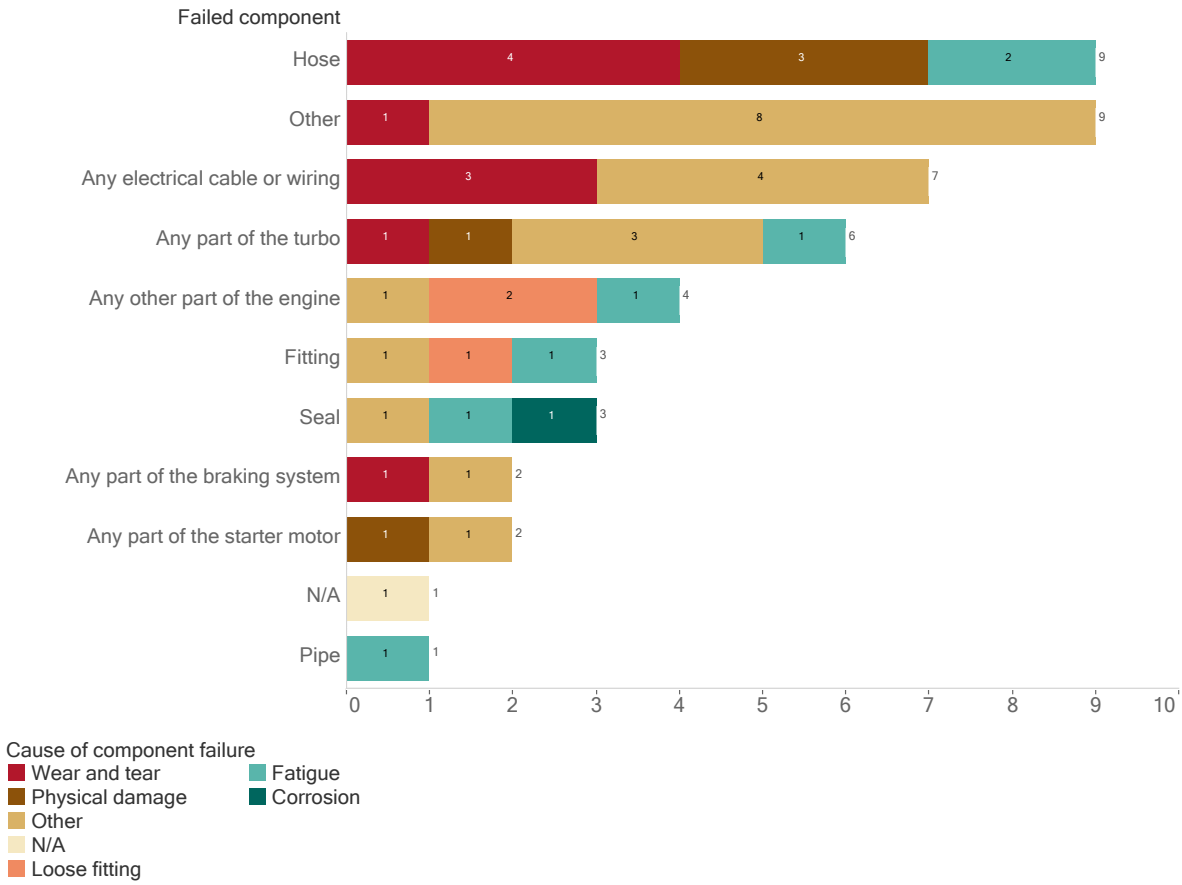


*Table 5: Ancillary reports - failed component and cause of component failure, between 1 April 2020 and 30 June 2021*[2]

| FAILED COMPONENT + CAUSE | FY 2020 Q4 | FY 2021 Q1 | FY 2021 Q2 | FY 2021 Q3 | FY 2021 Q4 | GRAND TOTAL |
|---|---|---|---|---|---|---|
| **Other + other** | 3 | 12 | 7 | 5 | 8 | **35** |
| **Hose + wear and tear** | 3 | 4 | 4 | 6 | 4 | **21** |
| **Any part of the turbo + fatigue** | 3 | 4 | 3 | 2 | 1 | **13** |
| **Any electrical cable or wiring + other** | 2 | 2 | 2 | 2 | 4 | **12** |
| **Hose + physical damage** | 3 | 2 | 2 | 2 | 3 | **12** |
| **Any electrical cable or wiring + wear and tear** | 1 | 1 | 1 | 3 | 3 | **9** |
| **Seal + other** | 5 | 1 | 1 | 1 | 1 | **9** |

[2] 9 or more incidents since 1 April 2020

# Incident details

The information in the table provides a brief summary of the incident and the reported apparent cause.

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine the operator of a Caterpillar 6060 excavator was preparing to load a truck, the fire alarm started to sound. The operator viewed the in-cab engine video monitors and noticed flames on the right-hand engine. The operator shut down the machine, initiated an emergency and manually actuated the fire suppression system, which extinguished the fire. | Failure of the right-hand engine's left side turbo shaft bearing.<br>The turbo had only been in service for 982 hours at the time of failure. |
| At an underground metalliferous mine, an operator was changing a shank on an Atlas Copco Boomer M2D (Jumbo) when he noticed a small flame between the booms adjacent to ELV wiring for lights. The operator extinguished the fire with his water bottle and isolated the Jumbo unit. | Hydraulic hose rubbed through the plastic sheath on the resin shooter electrical cable causing an internal short within the cable. |
| At an open cut coal mine, the operator of Komatsu 830E AC dump truck was descending a ramp on the west BLA bench returning to the loader when the truck lost propulsion. A dump truck operator following the Komatsu 830E haul truck noticed sparks coming from the retard grid box and an emergency was called. The dump truck was parked fundamentally stable, the fire system was activated, the haul truck was switched off and the operator disembarked. The truck was then isolated at the battery isolator and emergency services attended the scene. | Failure of older style resistor grids in the resistor grid box. |
| At an open cut coal mine, the operator of a Caterpillar D11T dozer was cleaning up around the excavator bench when they noticed flames coming from the engine bay. The fire suppression system automatically activated. There was residual small flames, which were extinguished by operator using a 9kg hand-held unit. | Incorrect routing and segregation of the implement hose, allowing the hose to make contact with the implement pump, causing wear and leading to failure. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, an operator of a Caterpillar MD6290 drill was tramming between holes when it shutdown unexpectantly. The operator attempted to restart the drill but was unsuccessful. The operator then noticed a small fire on the engine starter motor. The operator extinguished the fire using a hand-held fire extinguisher. | The engine starer motor solenoid positive terminal post insulator was damaged, allowing arcing to occur between the positive post and the starter motor solenoid. The damaged terminal and subsequent arcing resulted in heating of the electrical terminal causing a small localised fire. |
| At an open cut coal mine, an operator of a Komatsu 830 dump truck was hauling to a dump down a new pit 1 ramp. The operator came over the crest of the ramp at 30km/h and attempted to slow the truck using the retarder, but was unsuccessful. The operator applied the service break to slow down when a witness in a nearby light vehicle saw a small flame from the wheel motor cover area of position 5/6 wheels and called an emergency. The dump truck was brought to a stop at the toe of the ramp and the flame extinguished itself. | The dump truck operator was unfamiliar with the ramp/road design/grade and crested the ramp at 30 km/h. The dump truck operator was then unable to slow the truck using the electric dynamic retarder as it was outside its design envelope due to the speed it was travelling. The operator applied the service brakes at 62km/h to stop the dump truck. The frictional heating of the brake pads and discs ignited the fibreglass wheel motor cover. |
| At an open cut coal mine, an operator of a Caterpillar 793D dump truck identified smoke coming from engine bay and moved the machine to a safe location. The operator saw flames in the engine bay through gaps in the bonnet. The operator activated site emergency procedure, shut down the truck using the ignition key and manually activated the fire suppression before exiting the machine via the normal front access stairs.<br>Two open cut examiners (OCEs) arrived and attempted to put out the fire using three hand-held fire extinguishers, which was unsuccessful.<br>The OCEs then opened the engine bay bonnet to allow the water cart, which was already on standby at the scene, to use its water cannon to successfully extinguish the fire.<br>During an investigation it was identified that the machine fire suppression system failed to discharge at the time of the incident. | The cause of the fire was a significant oil leak on the steer tank suction pipe from which a large amount of oil was spilled onto the turbo lagging and exhaust manifold lagging, which subsequently soaked the lagging and ignited.<br>The cause of the oil leak was identified as the failure of a weld connecting an OEM hose clamp post to the suction pipe. This failure created a 15mm hole in the pipe and allowed a large volume of oil to escape under low pressure.<br>The cause of the fire suppression system failing to discharge was believed to be a low pressure in the nitrogen cylinder failing to provide enough pressure to rupture the burst disc, allowing for the dry chemical powder to distribute through the fire system. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an underground metalliferous mine, an operator of a Sandvik LHD 621 underground loader was returning to the stockpile area when they smelled something burning.<br>The operator stopped the loader to see what was burning when they noticed smoke coming from the hydraulic tank compartment. The operator shut down the loader, activated the fire suppression system and called an emergency. The fire was then extinguished using a hand-held fire extinguisher. | The brake pedal pressure transducer (B3058) harness had been run incorrectly and was wrapped around the brake control coils, resting against the brake accumulator discharge solenoid (Y3052) and harness. This allowed the harnesses to rub, resulting in a short that ignited the harness' outer sheaving. |
| At an open cut coal mine, an operator of a SKF98 drill had a hydraulic hose failure and the maintenance team was notified. While waiting for the maintenance team, the drill operator noticed a small fire on the starter motor. The operator stopped the machine using the emergency stop and put out the fire using a hand-held fire extinguisher. Once the fire was extinguished, the operator turned the battery isolator off. | The engine starer motor solenoid positive terminal post insulator was damaged, allowing arcing to occur between the positive post and the starter motor solenoid. The damaged terminal and subsequent arcing resulted in heating of the electrical terminal causing a small localised fire. |
| At the surface stockpile area for a metalliferous mine, a fitter was repairing an oil leak on a Komatsu PC1250 excavator. After completing the repair and degreasing the engine, the fitter was in the process of refitting the panels to the machine. The fitter then grabbed the 20l drum of BP quick break degreaser that was in the walkway and placed it onto the engine bay bonnet to allow then to shut the access door, in doing so the 20l drum fell over, the lid fell off and degreaser spilt across the bonnet and into the engine bay. The fitter saw flames coming from the engine bay area and went to activate the fire suppression system. By the time the fitter got to the activation point of the fire suppression the system had automatically activated and put out the fire. | The BP quick break degreaser that was spilt into the engine bay has come into contact with the exhaust system and ignited. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, an operator of a Caterpillar 992G loader was loading gravel into a truck when they noticed a warning message 'ejector error 6'. The operator contacted maintenance and was requested to bring the loader to the workshop after they had completed loading the truck.<br>The operator had just dumped the fourth bucket into the truck and was about to reverse when they saw flames from the top of the engine bay. The operator called an emergency and activated the fire suppression system, which extinguished the fire. | No.6 injector adjuster nut came loose, resulting in the hold down clamp bolt breaking and damaging the cylinder rocker cover.<br>Diesel and oil mixture escaped from cylinder rocker cover igniting on hot exhaust components. |
| At an open cut coal mine, an operator of a Caterpillar MD6310 drill saw a hydraulic hose fail causing oil to spray onto the exhaust then catch fire. The operator immediately stopped the machine, called emergency and extinguished the fire with a hand-held fire extinguisher. | The hydraulic hose was not adequately secured/ segregated causing wear and leading to failure. The released oil sprayed onto the exhaust igniting. |
| At an open cut coal mine, an operator of a Hitachi / Bell B50D articulated lube truck was driving along the haul road when they heard an emergency call for their truck. The operator stopped the truck, hit the emergency stop and activate the onboard fire system. The operator saw a small flame in between the cabin and rear module that went out shortly after. There were no nozzles from the fire suppression system in this area.<br>Before the incident, the truck had just returned to work from an offsite shutdown. | The flame seen in the park brake area was due to the pads rubbing against the disk. This caused excessive heat build-up and a flame.<br>Numerous defects were found that likely caused or contributed to the brake overheating which included.<br>• The brake appears to have been incorrectly adjusted.<br>• The oscillation joint (through shaft) yoke nut at the park brake was loose.<br>• The through shaft support bearing at the park brake had excessive wear.<br>• The through shaft spline was excessively worn. |
| At an open cut coal mine, an operator of a Caterpillar 994D loader saw flames coming out of the exhaust stack. The operator lowered the bucket and called emergency. The operator activated the fire suppression system. | Premature failure of the turbo bearing and seals allowing lubricating engine oil to enter the exhaust stream and be ignited by the hot gases.<br>The turbo failed at 3000 hours. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, a Caterpillar 24m grader was being operated on a haul road when it shut down for no known reason and lost all functions. The operator called the field mechanic who undertook fault finding including attempting to restart the engine when they noticed smoke coming out of the engine bay and exhaust. An emergency was called and the onboard fire suppression system was activated. No immediate cause of the smoke was identified but subsequent investigation found badly burnt wiring and solenoids contained within a circuit breaker and solenoid enclosure. | The partially melted cable lug and relay connection stud would suggest that a hot joint on the power relay was the cause of the heating in the enclosure that ultimately caused a smaller control relay sitting above the power relay to catch fire. Cutting of the cables did not reveal any evidence of overheating that may have pointed to overloading of the cable or the circuit as the cause. |
| At an open cut coal mine, an operator of a Caterpillar 793D dump truck was travelling up a ramp when they noticed flames near the exhaust muffler guard. The operator immediately parked the machine safely, manually activated the fire suppression system, shut down the machine and called emergency. The operator then used the onboard hand-held fire extinguisher to extinguish the fire. | The exhaust muffler cracked in two areas that heated up the muffler's sound suppression material that was potentially contaminated with oil. The sound suppression material then ignited. |
| At an open cut metalliferous mine, an operator of a Caterpillar 773E dump truck was lowering the body after dumping overburden when he noticed some smoke and flames coming from the driver's side of the vehicle. The operator immediately stopped the truck, obtained a hand-held fire extinguisher from the truck, put out the fire and an emergency was called. | The positive lead from the emergency steer motor to the starter relay was touching the hydraulic hose causing the hydraulic hose to rub through. This resulted in hydraulic oil spraying onto the engines turbo, causing a fire. |
| At an open cut coal mine, an operator of a Caterpillar D11 KSN dozer was working on a dump when they saw flames coming from the right-hand side of the engine bay. The operator lowered the blade, activated the emergency stop and fire suppression and called an emergency. The fire suppression system extinguished the fire. | The engine oil hose in the engine bay rubbed through against the aftercooler pipe. Failure of oil filter hose allowed oil on to the engine manifold and igniting. The aftercooler pipe was installed the wrong way around causing it to rub against the oil hose. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, an operator of a Caterpillar 785C dump truck was driving along a haul road to the dump when they noticed a drop in power, the operator then saw flames and smoke coming out of the exhaust. The operator stopped the truck and called the workshop. The operator then saw a glow through the engine cover. The fire suppression system automatically actuated and an emergency was called. The engine cover was lifted and the remaining small flame was extinguished with a hand-held fire extinguisher. | Failure of the impeller shaft on the RH turbocharger caused oil to escape into the hot side of the turbo which caused flames and smoke to come out of the exhaust pipe.<br>A small amount of oil leaked out of the clamp between the turbo housing and the exhaust pipe, which ignited. |
| At an open cut coal mine, an operator of a Caterpillar 793D dump truck was traveling from the north dump to the pit strip when the operator heard a loud noise and the truck lost power. The operator then saw flames coming from the off side of the truck from the exhaust.<br>The operator stopped the truck, shut it down and activated the fire suppression system and initiated emergency protocol.<br>Once the machine was shut down the fire self-extinguished due to the oil supply to the exhaust system being shut off. | The basic cause of the incident was the premature failure of the left-hand rear turbocharger. The turbocharger suffered a failure of the weld between the shaft and the turbine. This failure enabled oil to enter the exhaust system leading to the initiation of the fire in the exhaust system. |
| At an open cut coal mine, an operator of a Caterpillar 789C dump truck was driving on a haul road heading to the dump when they heard a popping noise. The operator saw a flame coming out of the exhaust pipe so the operator brought the truck to a stop and applied the park brake, shut the truck down and activated the fire system. | The cause of the incident was a premature turbo shaft failure. Once the turbine shaft broke and moved out of the turbo, it allowed engine oil to escape and contact hot exhaust components and ignite. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, an operator of a Caterpillar 24M grader reported to the in-pit fuel farm to fill the grader with coolant as the low level alarm was active. The grader operator was completing a walk around inspection when he noticed a small leak of coolant on the left hand side of the engine coming from the heater hose. The operator was asked to take the grader up to the hard stand where the fitter could inspect it. The fitter entered the grader engine bay on the left side where a small flame was found around the turbo area. The fitter extinguished the flame with a fire extinguisher. | On inspection, it was revealed that the heater hose had split adjacent to the hose clamp.<br>The hose was pulled tight and was too short creating tension at the joint leading to splitting. The hose was very long going to the cabin and was difficult to change out.<br>The coolant spraying from the leak soaked into the turbo lagging (was absorbent type Aletek lagging).<br>The coolant was absorbed by the lagging around the turbo. The water fraction boiled of,f leaving propylene glycol that caught alight. The water boiled off at about 100 degrees Celsius leaving the propylene glycol that boiled at 188 degrees Celsius. The propylene glycol then auto-ignited at 371 degrees Celsius. |
| At an open cut coal mine, a Liebherr 996B excavator blew an air conditioner motor hose that dripped hydraulic oil into the engine compartment, smoked and the fire system was manually activated by the operator. | The air conditioner motor hose running from the pump room to the air conditioner rubbed on an edge as it ran horizontally from under the floor mesh on the top deck to vertically down to the pump room causing it to fail.<br>The ruptured hose sprayed oil up on the top deck and underneath the grid mesh. Some of this oil dripped down into the engine bay and was blown by the cooling fan over hot components of the engine, causing it to ignite. |
| At an open cut coal mine, the operator of a Caterpillar D11T dozer noticed flames and smoke from the right side of the engine bay door. The operator immediately parked the machine, shut it down and manually activated the fire suppression system. The operator called an emergency then used the onboard 9kg fire extinguisher to assist the suppression system with extinguishing the fire. | The O-ring on the transmission filter failed, which sprayed oil onto the exhaust system igniting. There was a failure on the OEM filter and a potential filter installation issue. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, the operator of a Hitachi EH4500 haul truck was on the way to the excavator to be loaded when the truck lost propulsion. The operator called maintenance who attended the truck and commenced fault finding. The electrician and operator noticed smoke coming from the drive system cabinet. The electrician opened the cabinet door where the smoke was coming from and noticed small flames on the wiring of the grid blower contactor wiring. The electrician extinguished the flames with a fire extinguisher. | The grid blower contactor (K191) was serviced immediately before the failure. Immediately after the failure, the arc chute was identified as being installed incorrectly as there was a gap between it and the contactor base. This allowed hot gases from the contact tip arc to propagate from the arc chute to the surrounding electrical components. The hot gases melting the electrical components resulted in a small fire. |
| At an open cut coal mine, the operator of a Caterpillar D11T dozer was conducting bulk push activities when they noticed smoke coming from the engine cowling. Upon opening engine cowl, the operator saw a small fire on the right hand side rear of the engine. The operator shut the machine down with the e stop, manually activated the fire suppression system and called an emergency. The fire was then fully extinguished using a hand-held fire extinguisher. | The right hand side rear engine rocker cover bolts were over torqued causing two mating threads in the aluminium alloy rocker box housing to fail (strip out). The resulting loss of clamping force on the rocker cover oil seal caused the seal to leak oil onto the engine exhaust manifold where it ignited. |
| At an open cut coal mine, the operator of a Hitachi EH5000 haul truck was travelling loaded on the mine's loop road. The operator saw flames beside the cabin and called an emergency over the two way. The operator stopped the truck and the fire suppression deployed automatically. The fire system extinguished the fire. | The hose to the steering flow amplifier failed spraying hydraulic oil onto the exhaust system igniting. Lagging was missing from the rear exhaust flowerpot. The contributing factors for the hose failure were the loss of the outer covering on the hose, caused by a poorly fitted P clamp and the failure of a number of outer reinforcing layer wires from abrasion and corrosion and cyclic stress along with the length of time the hose was in service. |
| At an open cut coal mine, the operator of a Caterpillar 789C dump truck was travelling on the haul road when the operator saw smoke and flame coming from the exhaust. The operator stopped the machine, called an emergency and activated the fire suppression system. The operator than exited from the machine and isolated the machine. The ERT team and mining supervisor arrived at the site and opened the bonnet and used the water cannon to wet down the engine. | The turbo shaft failed where compressor wheel fits, the exhaust wheel and remaining shaft exited into the exhaust system allowing hot oil to make contact with hot internal exhaust components causing it to ignite. The turbo had not reached half-life at the point of failure. |

| DESCRIPTION | APPARENT CAUSES |
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| At the surface part of an underground coal mine, the driver of a MACK fleet liner truck was reversing his truck into position to tip coal on the stockpile when the truck's power cut out. The driver restarted the engine and continued to position the truck backwards when it cut out again. The driver applied the hand brake and got out to inspect the truck. While walking around the truck he smelled burning and noticed an orange glow underneath the truck cabin. The driver used the truck's fire extinguisher to extinguish the flame and notified their supervisor. | The P Clamp holding the cable from the battery in place failed. When this clamp failed, the battery cable fell onto the chassis moun,t which caused a short circuit. |
| At an open cut coal mine during a routine service of a Liebherr 996 excavator, a crack in the handrail above a hydraulic tank was identified. When boilermakers were repairing the cracked handrail, a bit of splatter landed on a pile of grease next to the hydraulic tank resulting in a small flame. The fire was extinguished using a 9kg fire extinguisher. | Boilermakers failed to identify combustible grease in the immediate location of the hot work activities, and failed to remove or cover the areas to prevent ignition. The boilermakers failed to revise/renew their permit and risk assessments for hot work when they changed location and task. |
| At an exploration drill site on the surface of a metalliferous mine, the operator of a Caterpillar D7H parked up the dozer in the area that he had cleared when called away to another job. When the operator returned to the drill site about an hour-and-a-half later, they noticed there was smoke and small flames coming from underneath and within the dozer cabin. The operator called for assistance and extinguished the flames with two fire extinguishers, a further three fire extinguishers were later discharged until smoke from smouldering ceased. | A small electrical fire was caused by a starter motor wire rubbing on a cross member on the chassis. This rubbed the insulation off the wire, earthed-out the exposed wire and melted the insulation, which caught fire. |
| At an open cut coal mine, the operator of a Caterpillar D10T dozer was parked up after finishing clean-up for the excavator. After two to three minutes, the fire suppression alarm started going off, the operator turned the key back on to accessories when the fire suppression system automatically activated. The fire was fully extinguished by onboard fire suppression system that deployed automatically. | One of the six identical engine valve covers was not installed correctly (All six bolts on the valve cover were found to be loose after the incident) allowing oil to leak out onto the exhaust system igniting. |

| DESCRIPTION | APPARENT CAUSES |
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| At an open cut coal mine, the operator of a Caterpillar 992K loader was being operated ROM pad loading when the operator identified low power. The operator parked and called the pit fitter. Evidence of a small fire was discovered on inspection. | An oil leak from the rocker cover due to the seal approaching end of life and worn threads in bolt holes allowed engine oil to weep past the seal and make contact with a hot surface.<br>The leaking seal was identified and replacement parts ordered and scheduled for repair. |
| At an open cut coal mine, the operator of a Caterpillar 992G loader was traveling up to the north dump when they saw smoke coming out of the engine bay. The operator turned the loader around and parked. The operator exited the cab to check where the smoke was coming from and noticed that there were small flames coming out of the engine bay. The operator activated the fire suppression system and called the emergency. The fire suppression system successfully put the fire out. | Fire was caused by the accessory drive bearing spinning in housing and blocking the oil gallery. This has caused over heating of the shaft and bearing igniting the engine oil. Engine was purchased second hand due to availability of engine parts and had not received OEM update to accessory drive bearing area. The most likely cause of this failure was due to the update not being done. |
| On the surface area of an underground metalliferous mine, an operator was conducting a pre-start inspection on a CAT 777F dump truck when they smelled an electrical burning smell and a whisper of smoke coming from the gear stick area.<br>The operator called the supervisor who attended and inspected the cabin, which was full of smoke. The supervisor looked under the console next to the seat and saw flames through a hole above an A/C vent. The supervisor then grabbed the fire extinguisher from next to the cabin and extinguished the fire. | Failed electrical component (indicator diode) that was destroyed due to the fire. |
| At an open cut coal mine, an operator of a Liebherr 996 excavator was loading a truck when they saw flames in the camera fitted in engine bay 2. The operator doubled checked the camera and could see flames, the operator also saw smoke over the boom arch hoses and smelled burning. The operator called an emergency when the fire alarm started and the audio warning the fire suppression was in the process of releasing. The operator shut down the machine and hit the fire suppression, but it had already activated automatically. | Flexible hose fitting stripped out of STC (stepped control timing). The valve fitting was stripped out during machine operation allowing atomised engine oil to be sprayed over the engine's exhaust system and igniting. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut quarry, an operator of a Volvo EC460CL excavator was jack hammering when they smelled smoke and stopped to look. The operator found the battery earth cable in the battery box had melted where it joined the body and was smoking with a small flame. The operator grabbed a hand-held fire extinguisher and put out the fire. | An 8-inch shifter bridged across the positive terminal and the body causing it to short out and catch fire. The battery cover was removed from the batteries for maintenance and not put back on. The operator changed over from bucket to the hammer and once finishing put the 8-inch shifter into the battery compartment directly on top of the batteries not realising the cover was missing. Once the excavator started to operate the shifter came into contact with the positive battery terminal and body. |
| At an open cut coal mine, an operator of a SKF-50 surface drill noticed oil leaks on the ground next to the two last holes drilled at the end of shift and let the oncoming operator know. While the oncoming operator was inspecting the drill for the origin of the leak, they noticed a small fire under the pre-lube motor along the electrical wiring. The operator shut the drill down and extinguished the fire with a hand-held fire extinguisher. | Testing and investigation of the pre-lube motor circuit found that the negative terminal post was not secured in position, had a missing insulator and displayed significant evidence of arcing between the terminal post and the motor housing.<br>The unsecured loose positive terminal and subsequent arcing resulted in heating the pre-lube motor endplate, damaging the gasket and allowing oil to leak from the pump body onto the surrounding area, electrical cable and conduit. The heat and arcing of the post ignited the oil-soaked equipment, causing a small localised fire. |
| At an open cut metalliferous mine, an operator of a Caterpillar D10T dozer was operating in the open pit when the operator noticed a flame in the right hand side of the engine bay. The operator activated the fire suppression, called an emergency over the 2-way and exited the machine. The initial fire suppression was unsuccessful in extinguishing the fire. The operator then extinguished the fire using two hand-held fire extinguishers. A water cart attended and was used on the area. | The initial cause was identified as a failed fuel line. The failed fuel line was a non-original equipment manufacturers (OEM) return line fitted to the machine after an engine rebuild.<br>Failure of a soldered metal fitting on the non-OEM diesel return fuel line fitted to the machine released diesel onto the exhaust system. |
| At an open cut coal mine, an operator of a Caterpillar D10T dozer was operating on a dump. The operator was reversing when the audible fire alarm sounded. He turned and observed smoke from the top of the engine covers. He parked up the dozer, manually activate the fire suppression system, called an emergency and alighted the dozer via RHS tracks. He opened engine bay doors on both sides of engine and did not see flames. | The fan hose rubbed due to incorrect routing on the positive terminal of the pre-lube motor caused a hole. Hydraulic fluid leaked as a mist from the hole and was drawn over the engine. The ignition point was not definitively identified, but was most likely exhaust or LHS turbo, both of which were lagged. It was also possible that electrical arcing from the 24v motor terminal on the braided fan hose wires ignited the oil. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an open cut coal mine, an operator of a Komatsu 730E water cart was driving down a ramp and saw sparks, smoke and flames coming from the bottom of the contactor box. The operator brought the truck to a stop, shut the machine down and called an emergency. He then extinguished the flame using a hand-held fire extinguisher. | Corrosion of the contactor enclosure over time has compromised the roof seal, which allowed the ingress of water onto the extended range contactor causing a flash over. The environmental conditions in which water carts are subject to is particularly harsh, over time corrosion and deterioration of the extended range contactor cabinet compromised the condition of an engineering control that was undetected. The design of the cabinet roof flange and seal arrangement was also inadequate to protect the equipment from the long-term effects of water exposure and corrosion. |
| At an open cut coal mine, an operator of a Liebherr R9250 excavator was walking it off the bench to set up for better access for maintenance on the machine when they saw the air conditioner had stopped working and the warning lights for the battery and blocked filters had come on. The operator saw smoke coming from engine area and sparks on the camera. The operator shut the machine down and called an emergency on the two way. The flames were extinguished using a hand-held fire extinguisher and then the area cooled with the water truck. | When the alternator seized up on the non-drive end of the shaft, it heated the internal sections of the alternator to a point where wire insulation caught fire. |
| At an open cut coal mine, an operator of a Caterpillar D11T dozer was working on dump preparation when they saw smoke emitting from the radiator fan area of the dozer and then identified flames on the right hand side of the engine bay. The operator stopped the dozer and called an emergency. The operator manually activated the fire suppression system, which extinguished the fire. | It was identified that the dual tilt pilot hose rubbed within the hose clamp due to an incompatible hose clamp causing excessive movement on the hose sheath. This resulted in a hose failure that sprayed hydraulic oil towards exhaust components, which ignited. |
| At an open cut coal mine, an operator of a Liebherr 996 excavator saw a shadow out the right hand side of the machine. At the same time, the operator heard an emergency call on the radio alerting them that the machine was on fire. The operator activated the fire suppression system and exited the machine. The fire was extinguished using the machine's deluge system and hand-held fire extinguishers. | The fire started from a hydraulic leak in the engine compartment. The hydraulic hose connection bolt failed due to excessive stress applied as a result of the hose pulling on the bolted joint. Incorrect hose routing resulted in hose pulling tight under power pack main structure during normal operation. Hose construction characteristics resulted in the hose shortening when oil pressure was applied to the circuit. |

| DESCRIPTION | APPARENT CAUSES |
|---|---|
| At an underground metalliferous mine, an operator of a JCB 718 concrete agitator was walking back to the truck from the tag board when they saw a glow underneath the rear of it. The operator called an emergency and the call was made for all underground personnel to proceed to refuge chambers or fresh air bases. The operator then proceeded to try to extinguish the fire with the hand-held fire extinguisher from the truck. Three other workers arrived and assisted the operator to extinguish the fire using hand-held fire extinguishers. Once the fire was out a water hose was set up to cool the affected area. | Retarder generated excessive heat from being left engaged while vehicle was parked and stationary. (designed to only be operating while moving for cooling requirement).<br>Excessive radiant heat from retarder unit being left switched on while machine was stationary caused the terminal covers and outer insulation on earth strap to melt and ignite. |
| At an open cut coal mine, an operator of a Caterpillar D11T identified an oil leak near the engine bay and proceeded to park the dozer in a safe place. The operator saw flames in the engine bay when exiting the dozer. The operator re-entered the cab, raised an emergency, activated the fire suppression system and exited the cab. The dozer operator, and an operator of another dozer in the area, identified that the fire was not completely out and discharged two 9kg extinguishers.<br>The dozer was inspected to confirm the fire was out. | The transmission filler tube plug did not seal. The compression seal failed to tighten as a result of corrosion/seized nut. Transmission oil was able to leak out of the filler tube onto hot engine surfaces. |

For further information refer to our dedicated Fires on mobile plant web page.

# Annexure A

## Changes to the duty to notify the Regulator

In February 2020, amendments to the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 saw a change to the duty to notify incidents involving fires on mobile plant to the NSW Resources Regulator.

In the definitions of 'high potential incidents' there was an additional incident added to clause 128(5):

> 128(5)(t) *an uncontrolled fire on mobile plant that is in operation (whether operated directly, remotely or autonomously)*

An uncontrolled fire on mobile plant is any fire or ignition that is not intended as part of the normal function of that item of mobile plant. This applies regardless of the level of damage or means of extinguishing the fire. Examples of fires and ignitions that are intended include internal combustion, flame heaters, such as on bitumen tankers, and maintenance works, such as welding and oxy cutting (unless control is lost during the task).

This clause also requires fires to be notified when they occur on autonomous plant operating without a worker present.

Any fire underground in a mine, including a fire on mobile plant, must still be reported as a dangerous incident under clause 179(b).

Where a worker or any other person is exposed to a serious risk to the person's health or safety from fire, the incident must be notified as a dangerous incident under clause 179(a)(ii).

For further information refer to the factsheet – Changes to Work Health and Safety (Mines and Petroleum Sites) notifications to the Regulator.