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## Fire on mobile plant and field equipment

This initiating event relates to the unwanted or unexpected combination of a fuel source and an ignition source on mobile and field equipment that results in fire.

Here, mobile and field equipment include self-propelled machines or machines that are transportable around the mine in order to perform core functions. Examples include dump trucks, industrial lift trucks (e.g. forklift), mobile cranes, earthmoving equipment, draglines, skid mounted equipment, lighting towers, continuous miners, stacker-reclaimers, shearers and shuttle cars, etc.

This may be a result of less than adequate design, inappropriate operational and maintenance practices, or unexpected external factors – including environmental conditions.

### The information in this initiating event does not address:

- fixed plant and infrastructure, see RISKGATE Fires Topic, Fire on fixed plant and infrastructure Initiating Event
- mobile crib rooms

### Loss of control of fuel source

**Flammable Liquids (motor fuel, lubricant, transformer fluid, hydraulic fluid, coolant)**



### CAUSE Leakage due to component damage/failure of flammable liquid systems

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#### Road design and maintenance

- Undertake an initial risk assessment to identify fire hazards based on expected type and use of equipment
- Assess individual elements/units in terms of their fit in the final integrated system
- Design and implement general terrain and management practices (for pit floors, underground and surface roads) that minimise vibration on vehicles to reduce component fatigue (e.g. concrete underground roads)
- Incorporate containment strategies to contain leaked flammable liquid (e.g. bunding, relative location or positioning)

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#### Equipment selected or designed to function reliably under expected operating conditions

- Original equipment manufacturers' (OEMs') designs should be consistent with industry and regulatory guidelines or standards. For further advice refer to MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002).
- Undertake an initial risk assessment (RA) for procurement to identify fire hazards based on expected type and use of equipment and operating conditions
- Undertake a detailed RA to assess individual elements/units in terms of their fit in the final integrated system
- Establish a mechanism or system that provides continuous improvement of mine site specifications that will develop, review and feedback into the design and procurement process
- Consider absorption of flammable liquids on lagging/shielding of heat or fuel source
- Consider accumulation of flammable liquids (e.g. pooling from leakage)

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#### Develop a maintenance strategy for flammable liquid systems

- Establish an electrical and mechanical management plan or equivalent to address flammable liquid systems; consider periodic specialist maintenance and inspections
- A risk assessment based maintenance regime should be developed that takes into account the application of the equipment
- Consider information contained in MDG 15 Guidance for Mobile and Transportable Equipment for Use in Mines (March 2002)
- Establish an introduction to site management plan or protocol for new equipment - installation and commissioning
- Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out
- Establish a defect management system that reports defects and associated corrective actions
- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
- Instigate awareness training for the identification of fire hazards
- Instigate familiarisation and competency training for maintenance procedures (e.g. correct routing, clamping, components, guarding, protection, shielding)
- Establish housekeeping standards that include the wash- or blow-down of machines to allow defects to be visible
- Adhere to OEMs' specifications and upgrades for all components or demonstrate a risk-based approach to change management
- Use monitoring systems (e.g. electronic) to monitor component integrity (e.g. sensors, fluid levels, temperature levels)

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#### Implement operational and maintenance practices to identify and manage

### mechanical damage or failure

- Implement a maintenance strategy which is in-depth and periodic, as well as operator pre-start (e.g. obvious issues, leaks) inspections for early detection of impending equipment failures
  - Establish and implement training for maintenance personnel in competencies for controlling flammable liquid system faults and failure mechanisms (including identification and familiarisation)
  - Use monitoring systems (e.g. electronic) to monitor operational behaviour leading to equipment damage (e.g. speed, overloading, equipment performance, vehicle monitoring system -VMS)
  - Use monitoring systems (e.g. electronic) to monitor component integrity (e.g. sensors, fluid levels, temperature levels)
  - Implement and maintain housekeeping standards including wash- or blow-down of machine to allow defects to be visible
  - Undertake audits by in-house or subject matter experts to confirm operational and maintenance practices are carried out to an acceptable standard (e.g. planned task observations, safety interactions)
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### Awareness, training and competency

- Site-based standards (for refuelling/refilling, combustible liquids transport, etc.)
  - Procedures (for refuelling/refilling, combustible liquids transport, housekeeping, etc.)
  - Training for maintenance personnel in competencies for controlling flammable liquid system faults and failure mechanisms (including identification and familiarisation)
  - Instigate awareness training for the identification of fire hazards
  - Instigate training in competencies associated with correct maintenance procedures (e.g. correct routing, clamping, components, guarding, protection, shielding)
  - Awareness of the defect management system that reports defects and associated corrective actions (e.g. missing cap or fitting)
  - Auditing and inspection - records and schedules (e.g. job task analysis/observation, planned task observation, safety observation)
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## **CAUSE Spillage or overfilling of flammable liquids**

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### Confirm use of fit-for-purpose (FFP) equipment, designed to reduce spillage during refuelling/refilling

- Use a FFP flammable liquid filling point (i.e. consider separation from heat sources, ease of access, size of cap, hose-to-hose connections, fuel type, location, etc.)
  - Adhere to original equipment manufacturers' (OEMs') specifications and upgrades (e.g. incorrect cap or fitting)
  - Confirm the overflow discharge point is remote from any heat source
  - Establish a maintenance procedure for flammable liquid dispensing equipment
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### Confirm safe refuelling/refilling procedure is in place

- Develop a risk-based refuelling/refilling procedure specific to equipment, site and operating conditions taking into account the original manufacturers' (OEMs') recommendations
  - Implement correct maintenance procedures (e.g. using flammable liquid as degreaser and/or flushing, service truck)
  - Reporting of spillages and incidents of non-compliance, that feedback to refuelling/refilling procedure
  - Post-fuelling/-filling walk around inspection to detect hoses disconnected prior to movement, overflows, etc.
  - Utilise spill response kits and procedures to enable timely clean-up of spillage
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Implement inspections and audits to confirm compliance with site-based refuelling/refilling standards

- Reporting of spillages and incidents of non-compliance, that feedback to site-based refuelling/refilling standards and procedures
- Undertake inspections and audits to confirm compliance with procedures

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Confirm combustible liquids transport site-based standards and procedures are in place

- Develop a risk-based procedure for transporting combustible liquids specific to equipment, site and operating conditions
- Appropriate use of fit-for-purpose equipment and containers that are designed to Australian Standards or equivalent (e.g. AS 1940 2004 The Storage and Handling of Flammable and Combustible Liquids)
- Undertake inspections and audits to confirm compliance with standards and procedures

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Awareness, training and competency

- Site-based standards (for refuelling/refilling, combustible liquids transport, etc.)
- Procedures (for refuelling/refilling, combustible liquids transport, housekeeping, etc.)
- Training for maintenance personnel in competencies for controlling flammable liquid system faults and failure mechanisms (including identification and familiarisation)
- Instigate awareness training for the identification of fire hazards
- Instigate training in competencies associated with correct maintenance procedures (e.g. correct routing, clamping, components, guarding, protection, shielding)
- Awareness of the defect management system that reports defects and associated corrective actions (e.g. missing cap or fitting)
- Auditing and inspection - records and schedules (e.g. job task analysis/observation, planned task observation, safety observation)



### **CAUSE Incorrect application of flammable liquid**

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Implement operational and maintenance practices to confirm use of appropriate flammable liquid

- Adhere to original equipment manufacturers' (OEMs') specifications (e.g. flammable liquid compatibility, fire resistant flammable liquids, signage, consider different connections for different fluid types)
- Restrict use of high volatile liquids underground (e.g. flash-point less than 61 degrees Celsius)

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Awareness, training and competency

- Adhere to original equipment manufacturers' (OEMs') specifications (e.g. flammable liquid compatibility, fire resistant flammable liquids, signage)
- Accurate procurement processes

**Coal**



### **CAUSE Accumulation or deposition of coal on mobile plant and field**

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### equipment

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- Confirm use of fit-for-purpose equipment, designed for the mining environment
  - Confirm equipment meets necessary hazardous area codes and dust-ignition proof standards (AS/NZS 60079 2012 Explosive Atmospheres; AS/NZS 4871 Series 2010 Electrical Equipment for Mines and Quarries), ingress protection (IP) rating, (e.g. sensitive equipment, seal of switchboard door)
  - Adhere to original equipment manufacturers' (OEMs') specifications and upgrades including certificates of conformity
  - Use shielding for bearings, brakes, lights on shuttle car, etc. (e.g. pitched roof)
- Utilise dust suppression systems
  - Use water suppression, scrubbers or extraction systems
  - Evaluate the design of equipment to minimise airborne coal dust
  - Implement appropriate methods for the disposal of collected dust
- Implement operational and maintenance practices to manage the accumulation or deposition of coal
  - Establish and implement training for maintenance personnel in competencies for identifying hazards associated with the deposition of coal dust (including identification and familiarisation)
  - Establish and implement training for maintenance personnel in competencies for identifying hazards associated with the accumulation of coal (including identification and familiarisation)
  - Implement and maintain housekeeping standards including the wash-down of machines
  - Do not overfill transport equipment to reduce the chance of coal spills onto mobile or field equipment
  - Undertake audits by in-house or subject matter experts so that operational and maintenance practices are carried out to site-based standards (e.g. planned task observations, safety interactions)
- Awareness, training and competency
  - Site-based standards (for vehicle operation and suppression systems, etc.)
  - Procedures for housekeeping, dust suppression systems, vehicle operation, etc.
  - Awareness of the defect management system that reports defects and associated corrective actions (e.g. maintenance)
  - Auditing and inspection - records and schedules (e.g. job task analysis/observation, planned task observation, safety observation)
  - Training for maintenance personnel in competencies for controlling hazards associated with the accumulation and deposition of coal

### Other Solids

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### **CAUSE Presence and/or accumulation of flammable material on mobile plant or field equipment**

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- Confirm use of fit-for-purpose equipment, designed for the mining environment
  - Shield potential ignition sources, pre-purchase and retrofit (e.g. exhausts, engine manifolds, bearings, sealed brake drums, lights on shuttle car to prevent coexistence of fuel and ignition)

source)

- Develop a maintenance strategy to control accumulated materials on mobile plant and field equipment
  - Develop a risk assessment based maintenance regime that takes into account the application of the equipment
  - Establish operating standards for housekeeping and cleanliness (e.g. non-smoking, hot work requirements, suppression systems)
  - Design and install purpose-built spill-proof fluid filling and extraction systems (e.g. oil or diesel) to eliminate the need for rags in cleaning up spills
  - Provide non-flammable materials for maintenance tasks (e.g. absorbent kitty litter)
  - Develop a process for capturing unusual external factors leading to the accumulation of material resulting in serious consequences that will also drive innovation design and new technologies (i.e. an incident tracking system)
  - Establish post-maintenance inspection and certification prior to return to service to address repeat events
  - Develop service sheets and maintenance procedures for unique plant and machinery arriving on site for the first time
- Implement operational and maintenance practices to control accumulated material on mobile plant and field equipment
  - Implement operator pre-start inspections to detect any accumulated material
  - Implement and maintain housekeeping standards including cleaning of equipment and work environment to remove all flammable material (e.g. secure disposal bins)
  - Establish inspections, observations and interactions regarding work area housekeeping
  - Develop practices that minimise or preclude the need for flammable materials (e.g. rags, wood)
- Awareness, training and competency
  - Instigate familiarisation and competency training for housekeeping standards and procedures
  - Instigate awareness training for the identification of fire hazards associated with the accumulation of materials

### Pressurised Gases

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## CAUSE Unexpected release of flammable gas on mobile plant or field equipment

- Confirm equipment is designed for the mining environment
  - Undertake an initial risk assessment for procurement and selection of appropriate equipment (e.g. consider not using gas-fuelled equipment)
  - Adhere to original equipment manufacturers' (OEMs') specifications and upgrades including certificates of conformity
  - Hoses and fittings designed and installed for the mining environment (e.g. match components with type of gas)
  - Do not use components that are prone to leakage, incompatible ferrules, or regulators
  - Use gas detectors to check for leaks (i.e. hand held or installed on equipment)
  - Be aware of defective design and unauthorised modifications to design
- Develop and implement an operational and maintenance strategy for pressurised gas-

### fuelled mobile plant

- A risk assessment based maintenance regime should be developed that takes into account the application of the equipment (e.g. MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002))
- Establish an electrical and mechanical management plan or equivalent to address pressurised gas-fuelled mobile plant; consider periodic specialist maintenance and inspections
- Establish a mechanism or system that provides continuous improvement of mine site specifications that will develop, review and feedback into the design and procurement process
- Develop a process for capturing unusual external factors leading to flammable gas leakage resulting in serious consequences that will also drive innovation design and new technologies (i.e. an incident tracking system)
- Implement inspections for early detection of impending equipment failures (e.g. obvious leaks, cracks)
- Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out
- Establish a defect management system that reports defects and associated corrective actions (e.g. worn, aged or damaged components)
- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
- Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management

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Develop and implement an operational and maintenance strategy for pressurised gas used in welding and cutting

- A risk assessment based maintenance regime should be developed that takes into account the application of the equipment (e.g. MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002))
- Establish a mechanism or system to that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
- Establish adequate separation between pressurised cylinders and ignition source/s, especially cylinders used in cutting and welding (e.g. distance or barrier)
- Develop a process for capturing unusual external factors leading to flammable gas leakage resulting in serious consequences that will also drive innovation design and new technologies (i.e. an incident tracking system)
- Implement inspections for early detection of impending equipment failures (e.g. obvious leakage or cracks)
- Schedule original equipment manufacturers' (OEMs') recommended maintenance, inspections and services, including lead indicators and life-cycle change-out
- Establish a defect management system that reports defects and associated corrective actions (e.g. worn, aged or damaged components)
- Undertake audits by in-house or subject matter experts to confirm operational/maintenance practices are carried out to an acceptable standard (e.g. planned task observations, safety interactions)
- Adhere to original OEMs' specifications and upgrades or demonstrate a risk-based approach to change management

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Develop and implement operational and maintenance practices for pressurised gas storage and transportation

- Undertake an initial risk assessment to determine operational and maintenance practices for pressurised gas storage and transportation
- Develop site-based standards based on outcomes of risk assessment
- Consider using guidance from AS 1674 Series 2007 Safety in Welding and Allied Processes; AS 1335 1995 Hose and Hose Assemblies for Welding, Cutting and Allied Processes; or Welding

Technology Institute of Australia (WTIA) Technical Notes (full set) Establishing Operational and Maintenance Practices for Pressurised Gas Storage and Transportation

- Be aware of defective design and unauthorised modifications to design
  - Use gas detectors to check for leaks
  - Implement inspections for early detection of impending equipment and/or component failures (e.g. obvious leakage or cracks)
  - Implement and maintain housekeeping standards including the cleaning of equipment to allow defects to be visible
  - Restrain gas cylinders when being transported
  - Hoses de-pressurised during transport when appropriate (e.g. turn cylinders off)
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Awareness, training and competency

- Site-based standards for hot work, transport and storage of cylinders, etc.
- Procedures for hot work, refilling tanks, operation and maintenance (e.g. hoses, gas fuelled vehicles, cylinders, welding or heating equipment), and housekeeping, etc.
- Training in competencies for controlling failure mechanisms associated with the use of pressurised gas (including identification and familiarisation)
- Awareness and identification of fire hazards associated with the use of pressurised gas
- Awareness of the defect management system that reports defects and associated corrective actions
- Auditing and inspection - records and schedules (e.g. job task analysis/observation, planned task observation, safety observation)

### Other Flammable Fluids



### CAUSE Use of flammable fluids for cleaning

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Implement operational and maintenance procedures for cleaning mobile plant and field equipment

- Consider alternate cleaning fluid with reduced or non-flammable rating (e.g. dry ice for electrical components)
- Establish training for maintenance personnel in competencies for controlling hazards associated with the use of flammable cleaning fluids (e.g. hot surfaces and pooling)
- Develop a hazardous substance management procedure (Note, confirm that material safety data sheets (MSDSs) are readily accessible or visible)
- Utilise a spill response kit and procedure for the timely clean-up of spilled cleaning fluid
- Reporting of spillages and incidents of non-compliance, that feedbacks to housekeeping procedures

### Methane Gas on the Surface



### CAUSE Fugitive emission of methane gas during the mining process; especially after blasting and from uncapped boreholes (Note, light- and heavy-vehicles could act as an ignition source to cause a methane ignited fire)

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Develop a strategy for control of methane gas emissions during the mining process

- Undertake a risk assessment (RA) for potential methane emissions
  - Develop a RA based management plan to control methane emissions (including gas drainage where necessary)
  - Establish an auditing process to evaluate the efficiency or effectiveness of management plans
  - Instigate awareness training for the identification of fire hazards related to gas emissions
  - Establish housekeeping standards
  - Develop a process for capturing methane leakage events that drive innovation, design and new technologies (i.e. an incident tracking system)
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Confirm use of fit-for-purpose equipment designed for the mining environment

- Adhere to original equipment manufacturers' (OEMs') specifications and upgrades including certificates of conformity
  - Use of intrinsically safe or flameproof equipment (e.g. especially for mobile equipment working near to highwall after blasting)
  - Use methane gas detectors with a power shut-off component that automatically shuts down equipment when gas levels reach flammable limits
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design/procurement process
  - Be aware of defective design/unauthorised modifications
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Implement operational and maintenance practices to identify and manage fugitive methane emissions

- Implement inspections to detect methane emissions (particularly after blasts)
  - Use monitoring systems (electronic/manual) to monitor gas emissions
  - Establish adequate separation (e.g. distance or barrier) between methane gas emissions and potential ignition source/s (e.g. light- or heavy-vehicles)
  - Instigate awareness training for the identification and reporting of methane gas emissions (e.g. mobile plant operators)
  - Implement a maintenance process for mobile plant and field equipment
  - Implement a maintenance process for monitoring systems (including calibration, adhere to AS 2290.3 1990 Electrical equipment for coal mines - Maintenance and overhaul, Part 3: Maintenance of gas detecting and monitoring equipment)
  - Implement gas calibration processes (refer to AS 2290.3 1990 Electrical equipment for coal mines - Maintenance and overhaul, Part 3: Maintenance of gas detecting and monitoring equipment)
  - Implement and maintain housekeeping standards for cleanliness and access to gauges/monitoring devices
  - Establish corrective actions for operator behaviour not complying with standards and procedures (e.g. formal disciplinary action)
  - Undertake audits by in-house or subject matter experts to confirm operational/maintenance practices are carried out to an acceptable standard (e.g. planned task observations, safety interactions)
  - Instigate familiarisation and competency training for maintenance procedures (e.g. gas monitoring and calibration)
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PRECONTROL Awareness, training and competency

- Site-based standards (for gas monitoring and detection, specific competencies, gas detector's ticket to conduct atmospheric monitoring, etc.)
- Procedures (for gas management system installation, operation, maintenance and housekeeping, etc.)
- Instigate awareness training for the identification of post-blast methane gas emissions and fire-related hazards
- Training in competencies for correct maintenance procedures (e.g. gas monitoring, calibration)
- Awareness of the defect management system that reports defects and associated corrective actions

- Auditing/inspection - records and schedules (e.g. job task analysis/observation, planned task observation, safety observation) that confirms compliance with the gas management standards/procedures

### Loss of control of ignition source

#### Electrical



### CAUSE Faulty electrical equipment

#### Road design and maintenance

- Design general terrain and implement management practices (for pit floors, underground and surface roads) that minimise the level of vibration on vehicles to reduce component fatigue (e.g. concrete underground roads)
- Confirm good cable management practices on draglines and similar equipment to reduce wear and tear and collision (e.g. consider cable crossovers, conduits to prevent vehicles driving over cables)
- Consider height of powerlines over roadways, relative to mobile plant equipment (e.g. haul trucks/equipment hitting a powerline)
- Implement appropriate signage at crossings, with reference to overhead powerlines
- Implement change management plan for new roads and realignment of roads in vicinity of powerlines

#### Electrical equipment and components selected or designed to function reliably under expected operating conditions

- Undertake an initial risk assessment for procurement to identify fire hazards based on expected type and use of equipment and operating conditions
- Develop site-based standards based on outcomes of risk assessment
- Consider using guidance from AS 3007 Series 2007 Electrical Installations for Surface Mines; AS/NZS 2081 2011 Electrical Protection Devices for Mines and Quarries; and AS 4176 1994 Polyethylene/Aluminium and Cross-Linked Polyethylene/Aluminium Macro-Composite Pipe Systems for Pressure Applications
- Confirm that original equipment manufacturers' (OEMs') designs comply with site-based standards (e.g. intrinsically safe and flameproof equipment)
- Design to consider rating of protective devices, arc fault containment, vibration mounting, suitable separation distances between electrical components and other services (e.g. electrical cables rubbing), and ruggedness of components (industrial vs. domestic)
- Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process

#### Develop a maintenance strategy for electrical components

- Establish an electrical engineering management plan or equivalent to address electrical systems; consider periodic specialist maintenance and inspections
- Develop a risk assessment based maintenance regime according to the application of equipment
- Establish an introduction to site management plan or protocol for new equipment - installation and commissioning
- Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out (e.g. batteries, capacitors, switch gear, transformer oil leading to breakdown of insulation properties, draglines)
- Establish a defect management system that reports defects and associated corrective actions
- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy (e.g. periodically verify protection settings, ratings of protective devices,

adhere to approved ratings and settings)

- Establish housekeeping standards that includes the wash-down of machines to allow defects to be visible (consider use of dry ice cleaning)
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management
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### Implement operational and maintenance practices to identify and manage damage or failure

- Implement a maintenance strategy which is in-depth and periodic, as well as operator pre-start inspections for early detection of impending equipment failures (e.g. wear and tear, terminal corrosion or pitting, evidence of heating, arcing and sparking)
  - Schedule original equipment manufacturers' (OEMs') and site maintenance inspections and services, including lead indicators and life-cycle change-out (e.g. batteries, capacitors, switch gear, transformer oil leading to breakdown of insulation properties - draglines, defect repair, component test, thermal imaging of electrical components, vibration analysis, electrical discharge (e.g. corona discharge), cable management (trailing cables), correctly re-energising or de-energising equipment)
  - Instigate operational practices to minimise damage to electrical cables from shuttle cars, draglines, continuous miners, etc. (e.g. use of signs, berms, cross-over points)
  - Consider the use of monitoring systems (e.g. temperature monitoring system) to detect at-risk operational behaviour including inappropriate equipment (electric motor or switch gear) use leading to damage
  - Implement and maintain housekeeping standards including wash- or blow-down of machine to allow defects to be visible (consider use of dry ice cleaning)
  - Undertake audits by in-house or subject matter experts to confirm operational and maintenance practices are carried out to an acceptable standard (e.g. planned task observations or safety interactions)
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### Awareness, training and competency

- Refer to industry standards (including AS 3007 Series 2007 Electrical Installations for Surface Mines; AS/NZS 2081 2011 Electrical Protection Devices for Mines and Quarries; AS/NZS 4871 Series 2010 Electrical Equipment for Mines and Quarries) in development of site-based standards for installation, cables under tension, cable type (steel wired armoured vs. PVC) and sizing, coiling of cables, light fittings (restrained fittings), ingress protection (IP) ratings, etc.
  - Establish and implement training in competencies for maintenance procedures (e.g. routing, clamping, components, guarding, impact or abrasion protection, shielding, protection settings and ratings)
  - Establish and implement training in competencies for controlling electrical system faults or failure mechanisms (e.g. wear and tear, terminal corrosion or pitting, evidence of heating, arcing, sparking)
  - Establish and implement training in competencies for controlling fire hazards associated with electrical installation and fitting of components, including contractors
  - Awareness of the defect management system that reports defects and associated corrective actions
  - Auditing and inspection - records and schedules (e.g. job task analysis and observation, planned task observation, safety observation)
  - Awareness of the introduction to site management plan or protocol outlining the requirements when bringing new equipment on site
  - Awareness of the change management process so that modifications meet required standards
  - Instigate operator training on hazards associated with inappropriate operation of electrical equipment
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## Inappropriate use or application of electrical equipment

- Electrical equipment and components selected or designed to function reliably under expected operating conditions
  - Undertake an initial risk assessment (RA) for procurement to identify fire hazards based on expected type and use of equipment
  - Develop site-based standards based on outcomes of RA
  - Consider using guidance from AS 3007 Series 2007 Electrical Installations for Surface Mines and AS/NZS 2081 2011 Electrical Protection Devices for Mines and Quarries in the development of site-based Standards
  - Confirm that original equipment manufacturers' (OEMs') designs comply with site-based standards
  - Design to consider rating of protective devices, arc fault containment, vibration mounting, suitable separation distances between electrical components and other services (e.g. electrical cables), ruggedness of components (industrial vs. domestic), etc.
  - Use equipment certified and approved for use in regard to zones of the underground environment (e.g. in compliance with regulations)
  - Consider equipment with alarms or engineered vehicle immobilisation controls that alert or prevent inappropriate equipment in a specific location
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Establish an introduction to site management plan or protocol for new equipment - installation and commissioning
  - Establish a change management process so that modifications meet required standards or OEMs' specifications
- Inspections and audits to confirm compliance with site-based standards and procedures
  - Schedule and undertake inspections and audits to confirm equipment is appropriate for its location
  - Schedule and undertake inspections and audits to confirm equipment is appropriate for its use
  - Schedule and undertake inspections and audits to confirm compliance with procedures (e.g. live testing outside of 'live test' procedure)
- Awareness, training and competency
  - Refer to industry standards (e.g. AS 3007 Series 2007 Electrical Installations for Surface Mines and AS/NZS 2081 2011 Electrical Protection Devices for Mines and Quarries) in development of site-based standards for installation, cables under tension, cable type (steel wired armoured vs. PVC) and sizing, coiling of cables, light fittings (restrained fittings), ingress protection (IP) ratings, etc.
  - Procedures for testing and fault finding of electrical circuits, working in close proximity to conductors (high voltage (HV) and low voltage (LV)), live testing, isolation, penetration and excavation, welder duty cycle, welding category, etc.
  - Awareness of the defect management system that reports defects and associated corrective actions
  - Auditing and inspection - records and schedules (e.g. job task analysis and observation, planned task observation, safety observation)
  - Awareness of the introduction to site management plan or protocol for new equipment-installation and commissioning
  - Awareness of the change management process so that modifications meet required standards
  - Instigate operator training on hazards associated with inappropriate operation of electrical equipment
  - Electrical competencies for intrinsically safe and flameproof equipment



CAUSE

### Discharge of static electricity causing an incendive spark

- Equipment selected or designed to minimise static build-up
  - Equipment used to be fire resistant anti-static (FRAS) consistent with industry and regulatory guidelines (e.g. AS 3007 Series 2007 Electrical Installations for Surface Mines and AS/NZS 2081 2011 Electrical Protection Devices for Mines and Quarries)
  - Undertake a risk assessment to identify the potential for static discharge from the equipment
  - Procure equipment that complies with site specification relevant to application and location
  - Implement a change management system for continued compliance with site specifications
  - Schedule and implement audits and inspections to confirm continued compliance with site specifications
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
- Account for the potential of static discharge while performing adhoc and routine tasks (e.g. replacing ropes on a dragline in high winds)
  - Undertake a risk assessment to identify the potential for static discharge during a task, specifically, maintaining integrity of earthing or grounding (e.g. open or interrupted earth circuit) and size and scale of discharge
  - Develop a safe work procedure to complete the task (particularly for routine and repetitive tasks)
  - Establish a defect management system that reports defects and associated corrective actions (e.g. ground wire missing)
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Establish an auditing process to evaluate the efficiency or effectiveness of the work procedure and include a periodical review of the earthing or grounding and that materials are compliant with site requirements
- Awareness, training and competency
  - Familiarisation and competency training about the potential for static electricity discharge when undertaking routine and non-routine tasks
  - Awareness and training of the sequential steps involved in completing a task safely with reference to static discharge (particularly for routine and repetitive tasks)
  - Instigate familiarisation and competency training for hazard awareness associated with non-routine jobs including the selection of correct equipment, the placement of temporary earth and a checklist for generic hazards including static discharge



CAUSE

### Residual electrical discharge

- Avoid the use of equipment with the potential for residual electrical discharge or locate it in non-critical areas
  - Where possible use other methods of storing energy (e.g. compressed-air and fluid, spring, gravity tower)
  - Where capacitors or batteries are required select them based on application to minimise the ignition risk

- If capacitors used for power factor correction are required, consider whether a site's power factor could be managed at the lease boundary substation rather than at multiple locations around the site
- Consider whether uninterruptible power supply (UPS) units, that use batteries, supply truly critical equipment

Confirm cabinets containing electrical storage devices are suitably vented, to prevent the build-up of flammable gasses

Place electrical storage devices with appropriately sealed cabinets

- Placing electrical storage devices in sealed cabinets will not prevent the initial ignition, but will prevent it from propagating (e.g. flameproof and arc fault containment switchboard)

Design systems to automatically de-power and discharge storage devices in certain conditions

- Use designs where discharge storage devices automatically de-power or discharge when cabinet doors are open, when explosive atmospheres are detected, or when failure of the storage device is detected
- Use designs where disconnection from main supply can be performed locally, or may be achieved by tripping supply further upstream

Confirm electrical storage devices are appropriately maintained

- Develop maintenance strategies for storage devices, including periodic inspection, testing and replacement
- Include storage devices in the site's electrical engineering management plan (EEMP)

Clearly identify electrical storage devices (batteries/capacitors)

- Use highly visible signs and labels to indicate the presence of electrical storage devices
- Use signs and labels to identify the need for isolation prior to access

Personnel are made aware of the risks presented by electrical storage devices

- Instigate awareness sessions, training and induction (e.g. taking care to discharge prior to access, the risks associated with electrical storage devices and live testing, including the use of insulated tools in case they are dropped across terminals)

### Friction



### CAUSE

## Damaged, faulty and/or inappropriate use of mechanical equipment

Mechanical equipment/components selected or designed to function reliably under expected operating conditions

- Undertake an initial risk assessment for procurement to identify fire hazards based on expected type and use of equipment and operating conditions
- Develop site-based standards for selection and design, based on outcomes of risk assessment
- Consider using guidance from Welding Technology Institute of Australia (WTIA) Technical Notes (full set)
- Confirm that original equipment manufacturers' (OEMs') designs comply with site-based standards
- Select equipment that is fit-for-purpose (e.g. consider vibration mountings, ruggedness of

components, correct sizing of clutches, compatible components, appropriate use of light alloys (aluminium, magnesium, titanium ignition)

- Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
- 

### Develop a maintenance strategy for mechanical components

- Develop a risk assessment based maintenance regime that takes into account the application of the equipment
  - Establish an introduction to site management plan or protocol for new equipment - installation and commissioning (e.g. fire resistant anti-static (FRAS) belting)
  - Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services including lead indicators and life-cycle change-out (e.g. bearings)
  - Establish a defect management system that reports defects and associated corrective actions
  - Establish an auditing process to confirm adherence to and evaluates the effectiveness of the maintenance strategy
  - Establish housekeeping standards that include the appropriate wash- or blow-down of machine to allow defects to be visible
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management
- 

### Implement operational and maintenance practices to identify and manage damage or failure

- Implement a maintenance strategy which is in-depth and periodic, as well as operator pre-start inspections for early detection of impending equipment failures (e.g. wear and tear)
  - Schedule original equipment manufacturers' (OEMs') and site maintenance inspections and services including, lead indicators, life-cycle change-out, defect repair, component test, thermal imaging of mechanical components, vibration analysis, etc.
  - Use monitoring systems (e.g. temperature monitoring system) to detect at-risk operational behaviour leading to equipment damage (e.g. brakes, tyres)
  - Implement and maintain housekeeping standards including wash- or blow-down of machine to allow defects to be visible, including removal of flammable materials in skids used in towed equipment (e.g. lighting plant, pump sleds)
  - Use OEMs' replacement parts to preclude the use of incompatible components or inferior products
  - Undertake audits by in-house or subject matter experts so that operational and maintenance practices are carried out to an acceptable standard (e.g. planned task observations and safety interactions)
- 

### Awareness, training and competency

- Establish and implement training in competencies for controlling fire hazards associated with mobile plant
- Establish and implement training in competencies for maintenance procedures (e.g. hose routing, clamping, guarding, impact and abrasion protection, shielding)
- Establish and implement training in competencies for controlling mechanical system faults and failure mechanisms (e.g. wear and tear, over-heating, correct amount and type of lubricant)
- Awareness of the defect management system that reports defects and associated corrective actions
- Auditing and inspection - records and schedules (e.g. job task analysis and observation, planned task observation, safety observation)
- Awareness of introduction to site management plan or protocol for the requirements when bringing new equipment on site
- Awareness of the change management process so that modifications meet the required standards
- Operator training on hazards associated with inappropriate operation of mobile plant (e.g. dry drilling where should be wet drilling, operating equipment outside)



CAUSE

### Foreign object jammed in moving equipment

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- Confirm use of fit-for-purpose equipment that is designed for the mining environment
  - Design equipment to preclude or prevent jamming with foreign objects (e.g. shielding of potential friction points, designed or retrofitted, including sealed brake drums, rock-deflectors, sealed-for-life bearings)
  - Undertake a risk assessment to identify potential areas requiring control for foreign object damage - refer to history, incident registers and standards, and implement controls as necessary
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
- Develop a maintenance strategy for mobile plant and field equipment
  - A site and risk assessment based maintenance regime should be developed that takes into account the application of the equipment (e.g. MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002))
  - Develop a process for capturing unusual external factors leading to the accumulation of material resulting in serious consequences that will also drive innovation design and new technologies (i.e. an incident tracking system)
  - Instigate post-maintenance inspections and certification prior to return to service to address repeat events
  - Develop service sheets and maintenance procedures for unique plant and machinery arriving onto site for the first time
- Implement operational and maintenance practices for mobile plant and field equipment
  - Implement operator and maintenance inspections to detect any accumulated material (e.g. wood in tyres)
  - Implement and maintain housekeeping standards including cleaning of equipment and work environment to remove all flammable material (e.g. secure disposal bins)
  - Instigate inspections, observations and interactions regarding work area housekeeping
  - Develop practices that minimise unsecured or unrestrained objects including bolts, tools, etc.
  - Develop processes that control the proximity of loose objects to moving machinery (e.g. do not use continuous miner as storage platform; do not place loose objects such as roof bolts on armoured face conveyor (AFC) gear box)
- Awareness, training and competency
  - Instigate training in competencies for housekeeping standards (e.g. restraining objects)
  - Instigate awareness training for the identification of fire hazards associated with the foreign objects

#### Hot Work



CAUSE

### Faulty or damaged hot work equipment

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- Hot work equipment/components selected or designed to function reliably under expected operating conditions

- Undertake an initial risk assessment (RA) for procurement to identify fire hazards based on expected type and use of equipment
  - Develop site-based standards for selection and design of hot work equipment based on outcomes of RA
  - Consider using guidance from MDG 25 Guideline for Safe Cutting and Welding at Mines (March 2003); Welding Technology Institute of Australia (WTIA) technical notes, including MS07 Welding Occupational Health and Safety Management System for Welding and Cutting in the Mining Industry; and/or AS 1674 Series 2007 Safety in Welding and Allied Processes
  - Confirm that original equipment manufacturers' (OEMs') designs comply with site-based standards
  - Select fit-for-purpose equipment - consider applicability for the mining environment, ruggedness of components, selection of hoses that are matched to the pressurised gas (e.g. Liquefied Petroleum Gas (LPG) hose for LPG gas), etc.
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
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Develop a maintenance strategy for equipment and components used in hot work

- Develop a risk assessment based maintenance regime that takes into account the application of the equipment
  - Establish an introduction to site management plan or protocol that considers the suitability of the current hot work maintenance protocol for new equipment
  - Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators, life-cycle change-out, and wear and tear
  - Establish a defect management system that reports defects and associated corrective actions
  - Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
  - Establish housekeeping standards that include the cleaning of hot work equipment to aid inspection for defects or damage
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management
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Implement operational and maintenance practices to identify and manage damage or failure of hot work equipment

- Implement a maintenance strategy which is in-depth and periodic, as well as operator pre-start inspections (e.g. obvious issues, leaks) for early detection of impending equipment failures (e.g. wear and tear)
  - Schedule original equipment manufacturers' (OEMs')/site's maintenance inspections and services
  - Implement and maintain housekeeping standards, including cleaning machine to allow defects to be visible
  - Use OEMs' replacement parts to preclude the use of incompatible components or inferior products
  - Undertake audits by in-house or subject matter experts so that operational and maintenance practices are carried out to an acceptable standard (e.g. planned task observations and safety interactions)
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Awareness, training and competency

- Establish and implement awareness training for the identification of fire hazards associated with hot work equipment or tools
- Establish and implement training in competencies for maintenance procedures (e.g. correct hose selection)
- Maintainer must have current competency on the equipment being used (e.g. system to trigger certificate renewal timing)
- Implement a system to issue hot work permits
- Establish and implement training in competencies for controlling system faults or failure mechanisms (e.g. wear and tear, spark containment, insulation)
- Awareness of the defect management system that reports defects and associated corrective

actions

- Auditing and inspection - records and schedules (e.g. job task analysis and observation, planned task observation, safety observation)
- Awareness of introduction to site management plan or protocol outlining the requirements for bringing new equipment on site
- Awareness of the change management process so that modifications meet required standards



### CAUSE Inappropriate use or practice of hot work equipment

Select work equipment and components that are appropriate for expected operating conditions and location

- Select equipment that is fit-for-purpose considering applicability for the mining environment, ruggedness of components, selection of hoses that are matched to the pressurised gas (e.g. LPG hose for LPG gas), etc.
- Undertake a risk assessment for the selection of hot work equipment in the mining environment to identify fire hazards based on expected location and use of equipment
- Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process

Implement operational practices to identify and prevent inappropriate use of hot work equipment (location and tools)

- Confirm that hot work is solely conducted by competent and authorised maintainers
- Develop, implement and revise operating procedures and guidelines for hot work
- Develop and implement a hot work permit system
- Modify work environment to isolate fire hazard (e.g. build fresh air containment in underground longwall, remove or wet down flammable materials and work area, use of a fire blanket)
- Monitor flammable gas levels so that they remain within acceptable levels
- Implement maintainer pre-start inspections that include the assessment of fire hazards in the work environment (e.g. actions, fire extinguishers, spark containment shields that prevent sparks reaching goaf area)
- Close-out hot work procedures so that location is free of hot work hazards (e.g. hot metal slag, smouldering debris, fumes) and relocate equipment to non-hazardous location

Awareness, training and competency

- Establish and implement training in the hot work permit system, awareness of operating environments, etc.
- Instigate awareness training for the identification of fire hazards associated with hot work equipment or tools
- Maintainer must have current competency on the equipment being used (e.g. system to trigger certificate renewal timing)
- Auditing and inspection - records and schedules (e.g. job task analysis/observation, planned task observation, safety observation)
- Awareness of the change management process so that modifications meet the required standards

### Lightning



### CAUSE Mobile plant and field equipment struck by lightning or damaged by

### close strike

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- Develop and implement a process to minimise potential for fire from lightning strikes
  - Undertake a risk assessment to identify and determine the need for lightning protection
  - Monitor lightning activity using meteorological forecasts and other early warning detection systems
  - Lightning protection or diversion systems should be installed in accordance with appropriate standards (e.g. National Fire Protection Agency 780 2011 Standard for Installation of Lightning Protection Systems; AS/NZS 1768 2007 Lightning Protection)
  - Provide timely communications to allow sufficient time for all exposed site personnel to seek appropriate safe shelter
  - Place equipment in protected area away from fuel sources (i. stop damage; ii. Stop spread to fleet)
  - Instigate awareness training for workers that highlights the risks of lightning strikes
  - Develop a trigger action response plan (TARP) for lightning and electrical storms that outlines responses to a storm at certain distances away from the mine (e.g. a staged response depending on distance)
  - Procedure for the use and protection of explosives in known lightning conditions

### Hot Surfaces



### CAUSE Fuel ignited by hot surface

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- Mechanical equipment, components and material selected or designed to function reliably under expected operating conditions
  - Undertake an initial risk assessment (RA) at procurement, or prior to retrofit, to identify the potential for hot surfaces to act as an ignition source and put controls in place
  - Develop site-based standards based on outcomes of RA
  - Consider using guidance from AS/NZS 3584 2005 Diesel Engine Systems for Underground Coal Mines
  - Select fit-for-purpose equipment (e.g. consider shielding and lagging for segregation, isolation and cooling of hot surfaces)
  - Confirm original equipment manufacturers' (OEMs') designs adhere to site-based standards (e.g. underground requirement for external surfaces not to be in excess of 150 degrees Celsius)
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
- Develop a maintenance strategy for mechanical components and equipment
  - Develop a risk assessment based maintenance regime according to the application of the equipment
  - Confirm shielding and lagging is in good order
  - Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out (e.g. lagging)
  - Establish a defect management system that reports defects and associated corrective actions
  - Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
  - Establish housekeeping standards to keep fuel away from hot surfaces (e.g. motor fuel, rags, wood, coal, grass)
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management

Implement operational and maintenance practices to identify and manage hot surfaces

- Implement operator pre-start inspections for early detection of impending equipment failures (e.g. wear and tear)
  - Schedule original equipment manufacturers' (OEMs)/site's maintenance inspections and services, including lead indicators, life-cycle change-out, defect repair, component test, thermal imaging of mechanical components, lubrication of mechanical parts, etc.
  - Use monitoring systems and alarms to detect hot surfaces (e.g. temperature monitoring system)
  - Implement and maintain housekeeping standards
  - Use of OEMs' replacement parts to preclude the use of incompatible components or inferior product (e.g. wrong lagging with inadequate heat transfer capacity)
  - Undertake audits by in-house or subject matter experts so that operational and maintenance practices are carried out to an acceptable standard, including planned task observations and safety interactions
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Awareness, training and competency

- Establish and implement awareness training consistent with appropriate regulations and standards concerning the identification of fire hazards associated with mobile plant (e.g. AS/NZS 3584.3 2012 Diesel Engine Systems for Underground Coal Mines, Part 3: Maintenance)
- Establish and implement training in competencies for maintenance procedures (e.g. shielding, lagging, cooling systems)
- Establish and implement training in competencies for controlling mechanical system faults or failure mechanisms (e.g. wear and tear, evidence of over-heating, amount and type of lubricant or coolant)
- Awareness of the defect management system that reports incidents where hot surfaces exceed mine site or equipment specifications and associated corrective actions
- Auditing and inspection - records and schedules
- Awareness of the change management process so that modifications do not create hot surfaces
- Instigate operator training on hazards associated with inappropriate operation of mobile plant that creates hot surfaces

### Miscellaneous Ignition Sources



CAUSE

## Mobile plant and field fire due to miscellaneous ignition sources

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Site policy and procedures addresses risks of naked flames

- Risk assessment to identify and determine the controls for use of naked flame (Note, not referring to hot work)
  - Develop and implement site policies and procedures that address the use of naked flames (e.g. restricted zones, restricted products, contraband for underground, personal protective equipment (PPE), hot work procedure, refuelling procedures)
  - Training and awareness on fire hazards in relation to naked flames (e.g. smoking during refuelling, welder operators not to carry butane lighters)
  - Audits and inspections to confirm compliance with procedures
  - Incident reporting system to provide feedback for continuous improvement
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CONSEQUENCE

## Personnel Injury or fatality on or near the mobile plant or field

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**equipment used in the surface mine environment**

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- Means of fire suppression and evacuation selected or designed to function reliably under expected operating conditions
  - Develop and/or consult site equipment technical specification/s that specifically considers fire risks (consider using guidance from: AS 5062 2006 Fire Protection for Mobile and Transportable Equipment; and Australian Technical Specifications ATS 5387.1 2006 Fire Safety Engineering, Part 1: Application of Fire Performance Concepts to Design Objectives)
  - Confirm that original equipment manufacturer's (OEM's) designs are consistent with industry and regulatory guidelines or standards (refer to MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002); ATS 5387.1 2006 Fire Safety Engineering, Part 1: Application of Fire Performance Concepts to Design Objectives)
  - Undertake an initial risk assessment for procurement to identify fire hazards based on expected type and use of equipment
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Consider using guidance from AS/NZS 3868 1991 Earth Moving Machinery - Design Guide for Access Systems (particularly section 6 Cab Entrance and Exit Opening Requirement for Alternative Exit)
  - Equipment operating procedure includes information on effective fire suppression and evacuation
  - Equipment provided with communication devices
  - Equipment provided with means to detect fire, alert operator and trigger fire suppression system (e.g. smoke, carbon monoxide (CO), heat detector)
  - Equipment provided with emergency air/oxygen breathing apparatus
  - Equipment provided with means of rapid evacuation
  - Equipment provided with capacity for external engine shutdown and external fire suppression activation (e.g. Earth Moving Equipment Safety Round Table (EMESRT) design philosophy for fire on mobile plant)
  - Equipment should be provided with emergency engine shutdown and fuel isolation capability (for example AS/NZS 3584.1 2008 Diesel Engine Systems for Underground Coal Mines Part 1: Fire Protected - Heavy Duty, Section 2: Design and Construction - Clauses 12: Fuel Systems, 13: Air Inlet Systems and particularly 16: Engine Shutdown Systems)
  - Equipment should be maintained in accordance with appropriate standards (for example AS/NZS 3584 2008 Diesel Engine Systems for Underground Coal Mines Part 3 - Maintenance and AS/NZS 3584.1-2 2008 Diesel Engine Systems for Underground Coal Mines Part 1: Fire Protected - Heavy Duty, Section 2 Design and Construction, Part 2.1: Designated Safe Area Barrier and the Standards cited therein)
  - Confirm fire suppression systems are integrated into emergency planning and emergency response procedure

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- Develop a maintenance strategy for fire suppression and evacuation on mobile plant
  - A risk assessment based maintenance regime should be developed that takes into account the application of the equipment (e.g. MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002))
  - Establish an introduction to site management plan or protocol for new machinery
  - Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out
  - Establish a defect management system that reports defects and associated corrective actions
  - Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
  - Establish housekeeping standards that include the wash-down of machines to allow defects to be visible
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change

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management

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Implement operational and maintenance practices to manage fire suppression and evacuation means on mobile plant

- Implement operator pre-start inspections for early detection of impending equipment failures (e.g. check fire suppression system pressure, check presence of fire extinguishers)
- Implement regular inspections conducted by the fire officer
- Use a defect management system that reports defects and associated corrective actions
- Implement and maintain housekeeping standards, including wash-down of machine to allow defects to be visible
- Include the maintenance of fire suppression and evacuation systems in electrical and mechanical engineering management plans

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Awareness, training and competency in fire suppression and evacuation on mobile plant

- Site procedures
- Awareness of the defect management system that reports defects and associated corrective actions
- Instigate awareness training for the identification of fire hazards
- Instigate training in competencies for correct maintenance of fire suppression and escape from the machine
- Training in competencies for correct use of fire suppression and evacuation
- Operators trained in evacuation drills

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Emergency response plan designed to function reliably under all operating conditions

- Develop and consult site equipment technical specification/s that specifically considers fire risks (for example the information contained within the Australian Technical Specification ATS 5387.1-8 Fire Safety Engineering, particularly Parts 1: Application of Fire Performance Concepts to Design Objectives and Part 8: Life Safety - Occupant Behaviour, Location and Condition, may be useful in developing specifications though their focus is on buildings rather than mobile plant)
  - Undertake an initial risk assessment (RA) to identify fire hazards based on expected type and use of equipment
  - Develop an emergency response plan according to the RA and regulatory requirements and guidelines that addresses both fire fighting and medical treatment
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Emergency response team (ERT) vehicles and personnel comprising fire fighting and first-aid specific to fire resources
  - Fire fighting reticulation system, including fire hydrants, fire blankets, secure evacuation areas and meeting points, and water-lines in fire resistant material
  - Trained first-aid personnel
  - Appropriate external medical support and transport (e.g. ambulances, helipad, helicopter, local medical practice)
  - Emergency communication system (e.g. satellite phone, dedicated emergency number, emergency contact list)
  - GPS to provide location information to external support services
  - Equipment capable of external engine shutdown and external fire suppression activation
  - Evacuation procedures in cases of potential explosions (e.g. tyre fires) including no-go zones
  - Emergency protocol for assessing the potential impact on other personnel and work areas
  - Notification process of next-of-kin for accidents and/or fatalities
  - Develop a site-specific procedure for managing fatalities (e.g. notification of police, regulatory authorities, preservation of scene, media management). For further advice refer to MDG 1029 Guidelines for Agency Coordination During Body Recovery at NSW Mines (October 2011).
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Develop and implement a strategy for maintaining the currency of the emergency response plan

- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the emergency response plan
  - Undertake suitable emergency exercises to review the effectiveness of the emergency response plan. Guidance for conducting suitable training exercises can be found in the Queensland Department of Natural Resources and Mines, Recognised Standard 08 1999 Conduct of Mine Emergency Exercises.
  - Undertake scheduled inspections to maintain medical response and fire fighting equipment
  - Periodic benchmarking of the elements of the emergency response systems
  - Update emergency contacts
- 

Awareness, training and competency in the emergency response plan

- Instigate training in competencies for fire suppression and evacuation procedures
  - Training of the emergency response team (ERT) personnel comprising fire fighting and first-aid (e.g. awareness of emergency shutdown on vehicles and external fire suppression activation, disconnection of batteries)
  - Awareness and competency of fire fighting reticulation systems including the use of fire hydrants, fire blankets, secure evacuation areas and meeting points
  - Competent first-aid personnel (including capacity to treat burns)
  - External personnel to be familiar with site emergency locations, communication protocols and procedures (e.g. ambulance services, awareness of helipad locations)
  - Awareness of evacuation procedures in cases of potential explosions (e.g. tyre fires), including no-go zones
  - Train appropriate personnel in the use of compressed air breathing apparatus (CABA)
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## **CONSEQUENCE Personnel Injury or fatality on or near the mobile plant or field equipment used in the underground mine environment**

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Means of fire suppression and evacuation selected or designed to function reliably under expected operating conditions

- Develop and consult site equipment technical specification/s that specifically considers fire risks (refer to Australian Technical Specifications ATS 5387.1-8 2006 Fire Safety Engineering)
  - Confirm that original equipment manufacturers' (OEMs') designs comply with site-based standards. For further advice refer to MDG 1 Guideline for Free-Steered Vehicles (July 1995); ATS 5387.1 2006 Fire Safety Engineering, Part 1: Application of Fire Performance Concepts to Design Objectives.
  - Undertake an initial risk assessment to identify fire hazards based on expected type and use of equipment
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Equipment operating procedure includes information on effective fire suppression and evacuation
  - Equipment provided with means to detect fire, alert operator and trigger fire suppression system (e.g. smoke, carbon monoxide, heat detector)
  - Equipment provided with emergency engine shutdown and fuel isolation (refer to AS/NZS 3584 2012 Diesel Engine Systems for Underground Coal Mines Part 3: Maintenance (e.g. stop vehicle moving, cut fuel source))
  - Fail safe nature or safety integrity levels (SIL) of equipment (refer to IEC 61508 2010 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems)
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Develop a maintenance strategy for fire suppression and evacuation on mobile plant

- A risk assessment based maintenance regime should be developed that takes into account the application of the equipment (e.g. MDG 1 Guideline for Free-Steered Vehicles (July 1995))
  - Establish an introduction to site management plan or protocol for new machinery
  - Mine site should schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out. For further advice refer to AS/NZS 3584 2012 Diesel Engine Systems for Underground Coal Mines Part 3: Maintenance
  - Establish a defect management system that reports defects and associated corrective actions
  - Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
  - Establish housekeeping standards that include the wash-down of machines to allow defects to be visible
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management
  - Include the maintenance of fire suppression and evacuation systems in electrical and mechanical engineering management plans
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Implement operational and maintenance practices to manage fire suppression and evacuation means on mobile plant

- Implement operator pre-start inspections for early detection of impending equipment failures (e.g. check fire suppression system pressure, check presence of fire extinguishers)
  - Implement regular inspections conducted by the fire officer
  - Use a defect management system that reports defects and associated corrective actions
  - Implement and maintain housekeeping standards, including wash-down of machine to allow defects to be visible
- 

Awareness, training and competency in fire suppression and evacuation on mobile plant

- Site procedures
  - Awareness of the defect management system that reports defects and associated corrective actions
  - Instigate awareness training for the identification of fire hazards
  - Instigate training in competencies for correct maintenance of fire suppression and escape from the machine
  - Training in competencies for correct use of fire suppression and evacuation, including identification and familiarisation
  - Operators trained in evacuation drills
- 

Emergency response plan designed to function reliably under all operating conditions

- Develop and consult site equipment technical specification/s that specifically considers fire risks (refer to Australian Technical Specifications ATS 5387 2006 Fire Safety Engineering)
- Undertake an initial risk assessment to identify fire hazards based on expected type and use of equipment
- Mine site should schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services, including lead indicators and life-cycle change-out. For further advice refer to AS/NZS 3584 2012 Diesel Engine Systems for Underground Coal Mines Part 3: Maintenance.
- Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
- Provision of appropriately trained site personnel for emergency response comprising of fire fighting, first-aid and rescue recovery

- Fire fighting system, including fire hydrants, fire depots, fire blankets, and water-lines in fire resistant material
  - Emergency response system (e.g. lifelines, fresh air bases, compressed air breathing apparatus (CABA) refilling stations, self contained self rescuers (SCSR) cache, fire doors, emergency sealing capacity)
  - Trained first-aid personnel
  - Mines rescue capacity (i.e. site and mutual emergency response)
  - Appropriate external medical support and transport (e.g. ambulances, helipad, helicopter, local medical practice)
  - Emergency communication system (e.g. surface satellite phone, dedicated emergency number, emergency contact list)
  - Equipment capable of external engine shutdown and external fire suppression activation
  - Evacuation procedures in cases of potential explosions (e.g. tyre fires), including no-go zones
  - Protocol for assessing the potential impact on other personnel and work areas
  - Notification process for next-of-kin of accidents and/or fatalities
  - Develop a site-specific procedure for managing fatalities (e.g. notification of police, regulatory authorities, preservation of scene, media management). For further advice refer to MDG 1029 2011 Guidelines for Agency Coordination During Emergencies and Body Recovery.
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Develop a strategy for maintaining the currency of the emergency response plan

- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the emergency response plan
  - Undertake suitable emergency exercises to review the effectiveness of the emergency response plan (refer to Queensland Guidance Note QGN 15 Emergency Preparedness for Small Mines and Quarries, 2010)
  - Undertake scheduled inspections to maintain medical response and fire fighting equipment
  - Periodic benchmarking of the elements of the emergency response systems
  - Update emergency contacts
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Awareness, training and competency in the emergency response plan

- Instigate training in competencies for fire fighting, evacuation procedures and the use of self contained self rescuers (SCSR)
  - Training of the emergency response team personnel comprising fire fighting, mines rescue and first-aid
  - Awareness and competency of fire fighting reticulation systems including the use of fire hydrants, etc.
  - Awareness and competency in self and aided escape
  - Competent first-aid personnel, including burns treatment capacity
  - External personnel to be familiar with site emergency locations, communication protocols, and procedures (e.g. ambulance services, awareness of helipad locations)
  - Awareness of evacuation procedures in cases of potential explosions (e.g. tyre fires), including no-go zones
  - Train appropriate personnel in the use of compressed air breathing apparatus (CABA)
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## **CONSEQUENCE Fire develops and damages or destroys mobile plant or field equipment in the surface mine environment**

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Means of fire suppression selected or designed to function reliably under expected operating conditions

- Develop and consult site equipment technical specification/s that specifically considers fire risks.

Relevant standards include AS 5062 2006 Fire Protection for Mobile and Transportable Equipment and Australian Technical Specifications ATS 5387.1-8 2006 Fire Safety Engineering

- Original equipment manufacturers' (OEMs') designs to comply with industry and regulatory guidelines or standards. For further advice refer to MDG 1 Guideline for Free-Steered Vehicles (July 1995) and ATS 5387 2006 Fire Safety Engineering
  - Undertake an initial risk assessment for procurement to identify fire hazards based on expected type and use of equipment
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Fire suppression system selected or designed in accordance with appropriate standards (e.g. AS/NZS 3584 2005 Diesel Engine Systems for Underground Coal Mines, Part 1: Fire Protected - Heavy Duty, Section 2: Design and Construction)
  - Equipment operating procedure includes information on effective fire suppression and evacuation, including selection of appropriate fire extinguishing agents for possible fire types
  - Equipment provided with communication devices
  - Equipment provided with means to detect fire, alert operator and trigger fire suppression system (e.g. smoke, carbon monoxide (CO), heat detector)
  - Equipment provided with capacity for external engine shutdown and external fire suppression activation (e.g. Earth Moving Equipment Safety Round Table (EMESRT) design philosophy for fire on mobile plant)
  - Equipment provided with emergency engine shutdown and fuel isolation (e.g. stop vehicle moving, cut fuel source). For further advice refer to AS/NZS 3584 2012 Diesel Engine Systems for Underground Coal Mines
  - Confirm fire suppression systems are integrated into emergency planning and emergency response procedure
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### Develop a maintenance strategy for fire suppression on mobile plant

- Develop a risk assessment based maintenance regime that takes into account the application of the equipment (e.g. MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002))
  - Establish an introduction to site management plan or protocol for new machinery
  - Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services including lead indicators and life-cycle change-out
  - Establish a defect management system that reports defects and associated corrective actions
  - Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
  - Establish housekeeping standards that include the wash-down of machines to allow defects to be visible
  - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management
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### Implement operational and maintenance practices to manage fire suppression means on mobile plant

- Implement operator pre-start inspections for early detection of impending equipment failures (e.g. check fire suppression system pressure, check presence of fire extinguishers)
  - Implement regular inspections conducted by the fire officer
  - Use a defect management system that reports defects and associated corrective actions
  - Implement and maintain housekeeping standards including wash-down of machine to allow defects to be visible
  - Include the maintenance of fire suppression systems in electrical and mechanical engineering management plans
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### Awareness, training and competency in fire suppression on mobile plant

- Site procedures

- Awareness of the defect management system that reports defects and associated corrective actions
  - Instigate awareness training for the identification of fire hazards
  - Instigate training in competencies for correct maintenance of fire suppression and evacuation
  - Training in competencies for correct use of fire suppression systems and evacuation, including identification and familiarisation
  - Operators trained in fire fighting drills and use of appropriate fire extinguishing agents for different fire types
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Emergency response plan designed to function reliably under all operating conditions

- Develop and consult site and business equipment technical specification/s that specifically considers fire risks. Relevant standards include AS 5062 2006 Fire Protection for Mobile and Transportable Equipment, and Australian Technical Specifications ATS 5387 2006 Fire Safety Engineering
  - Undertake an initial risk assessment (RA) to identify fire hazards based on expected type and use of equipment
  - A site and RA based maintenance regime should be developed that takes into account the application of the equipment (e.g. MDG 15 Guideline for Mobile and Transportable Equipment for Use in Mines (March 2002))
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
  - Site should develop an emergency response plan according to the RA and regulatory requirements and guidelines that address fire fighting. For further advice refer to MDG 1020 Guidelines for underground Emergency Escape Systems and the Provision of Self Rescuers (October 2010) and MDG 1022 Guidelines for Determining Withdrawal Conditions from Underground Coal Mines (October 2010)
  - Emergency response team (ERT) vehicles and personnel comprising fire fighting and first-aid specific to fire resources
  - Fire fighting reticulation system including fire hydrants, fire blankets, secure evacuation areas and meeting points, water-lines in fire resistant material, and appropriate fire extinguishing agents for possible fire types
  - Emergency communication system (e.g. satellite phone, dedicated emergency number, emergency contact list)
  - GPS to provide location information to external support services
  - Equipment provided with capacity for external engine shutdown and external fire suppression activation
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Develop and implement a strategy for maintaining the currency of the emergency response plan

- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the emergency response plan
  - Undertake suitable emergency exercises to review the effectiveness of the emergency response plan
  - Undertake scheduled inspections to maintain medical response and fire fighting equipment
  - Periodic benchmarking of the elements of the emergency response systems
  - Update emergency contacts
- 

Awareness, training and competency in the emergency response plan

- Instigate training in competencies for fire fighting procedures
- Training of the emergency response team (ERT) personnel comprising fire fighting and first-aid (e.g. awareness of emergency shutdown on vehicles and external fire suppression activation, disconnection of batteries)
- Awareness and competency of fire fighting reticulation systems including the use of fire hydrants, fire blankets, secure evacuation areas and meeting points, and selection of appropriate fire

- extinguishing agents for possible fire types
- External personnel to be familiar with site emergency locations, communication protocols, and procedures (e.g. ambulance services, awareness of helipad locations)
- Awareness of evacuation procedures in cases of potential explosions (e.g. tyre fires, gas cylinders, methane gas) including no-go zones
- Train appropriate personnel in the use of compressed air breathing apparatus (CABA)



### **CONSEQUENCE Fire develops and damages or destroys mobile plant or field equipment in the underground mine environment**

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- Means of fire suppression selected or designed to function reliably under expected operating conditions
    - Develop and consult site and business equipment technical specification/s that specifically considers fire risks. Relevant standards include AS 5062 2006 Fire Protection for Mobile and Transportable Equipment and Australian Technical Specifications ATS 5387.1-8 2006 Fire Safety Engineering.
    - Confirm original equipment manufacturers' (OEMs') designs adhere to industry and regulatory guidelines or standards (e.g. MDG 1 Guideline for Free-Steered Vehicles (July 1995); ATS 5387 2006 Fire Safety Engineering)
    - Undertake an initial risk assessment for procurement to identify fire hazards based on expected type and use of equipment
    - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the design and procurement process
    - Equipment operating procedure includes information on effective fire suppression and evacuation, including selection of appropriate fire extinguishing agent for possible fire types
    - Equipment provided with means to detect fire, alert operator and trigger fire suppression system (e.g. smoke, carbon monoxide, heat detector)
    - Equipment provided with emergency engine shutdown and fuel isolation (refer to AS/NZS 3584 2012 Diesel Engine Systems for Underground Coal Mines; e.g. stop vehicle moving, cut fuel source)
    - Fail safe nature or safety integrity levels (SIL) of equipment (refer to IEC 61508 2010 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems)
    - Establish an auditing process to confirm adherence to and evaluate the effectiveness of the maintenance strategy
  - Develop a maintenance strategy for fire suppression on mobile plant
    - Develop a risk assessment based maintenance regime that takes into account the application of the equipment (e.g. MDG 1 Guideline for Free-Steered Vehicles (July 1995))
    - Establish an introduction to site management plan or protocol for new machinery
    - Schedule original equipment manufacturers' (OEMs') recommended maintenance inspections and services including lead indicators and life-cycle change-out (See AS/NZS 3584 3 2012 Diesel Engine Systems for Underground Coal Mines, Part 3: Maintenance, for guidance on establishing maintenance systems)
    - Establish a defect management system that reports defects and associated corrective actions
    - Establish housekeeping standards that include the wash-down of machines to allow defects to be visible
    - Adhere to OEMs' specifications and upgrades or demonstrate a risk-based approach to change management
    - Include the maintenance of fire suppression and evacuation systems in electrical and mechanical engineering management plans
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Implement operational and maintenance practices to manage fire suppression means on mobile plant

- Implement operator pre-start inspections for early detection of impending equipment failures (e.g. check fire suppression system pressure, check presence of fire extinguishers)
  - Implement regular inspections conducted by the fire officer
  - Use a defect management system that reports defects and associated corrective actions
  - Implement and maintain housekeeping standards, including wash-down of machine to allow defects to be visible
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Awareness, training and competency in fire suppression mobile plant

- Site procedures
  - Awareness of the defect management system that reports defects and associated corrective actions
  - Instigate awareness training for the identification of fire hazards
  - Instigate training in competencies for correct maintenance of fire suppression and escape from the machine
  - Training in competencies for correct use of fire suppression systems and evacuation (including identification, familiarisation, and appropriate use of fire extinguishing agents for possible fire types)
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Emergency response plan designed to function reliably under all operating conditions

- Develop and consult site and business equipment technical specification/s that specifically considers fire risks. Relevant standards include AS 5062 2006 Fire Protection for Mobile and Transportable Equipment and Australian Technical Specifications ATS 5387.1-8 2006 Fire Safety Engineering
  - Undertake an initial risk assessment (RA) to identify fire hazards based on expected type and use of equipment
  - Develop an emergency response plan according to the RA and regulatory requirements and guidelines that addresses fire fighting (refer to MDG 1020 Guidelines for Underground Emergency Escape Systems and the Provision of Self Rescuers (October 2010); MDG 1022 Guidelines for Determining Withdrawal Conditions from Underground Coal Mines (October 2010))
  - Establish a mechanism or system that provides continuous improvement of mine site specifications and that will develop, review and feedback into the procurement process
  - Provision of appropriately trained site personnel for emergency response comprising of fire fighting
  - Fire fighting system including fire hydrants, fire depots, fire blankets, water-lines in fire resistant material, and selection of appropriate fire extinguishing agents for possible fire types
  - Emergency response system (e.g. lifelines, fresh air bases, compressed air breathing apparatus (CABA) refilling stations, self contained self rescue (SCSR) cache, fire doors, emergency sealing capacity)
  - Trained first-aid personnel
  - Mines rescue capacity (i.e. site and mutual emergency response)
  - Emergency communication system (e.g. surface satellite phone, dedicated emergency number, emergency contact list)
  - Equipment provided with capacity for external engine shutdown and external fire suppression activation
  - Evacuation procedures in cases of potential explosions (e.g. tyre fires) including no-go zones
  - Protocol for assessing the potential impact on other personnel and work areas
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Develop and implement a strategy for maintaining the currency of the emergency response plan

- Establish an auditing process to confirm adherence to and evaluate the effectiveness of the emergency response plan

- Undertake suitable emergency exercises to review the effectiveness of the emergency response plan. Guidance for conducting suitable training exercises can be found in the Queensland Department of Natural Resources and Mines, Recognised Standard 08 1999 Conduct of mine emergency exercises.
  - Undertake scheduled inspections to maintain fire fighting equipment
  - Periodic benchmarking of the elements of the emergency response systems
  - Update emergency contacts
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Awareness, training and competency in the emergency response plan

- Instigate training in competencies for fire fighting
- Training of the emergency response team personnel in fire fighting
- Awareness and competency of fire fighting reticulation systems including the use of fire hydrants, etc.
- External personnel to be familiar with site emergency locations, communication protocols and procedures (e.g. ambulance services, awareness of helipad locations)
- Awareness of evacuation procedures in cases of potential explosions (e.g. tyre fires) including no-go zones