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Managing Mobile Equipment Fire Risks

How to prevent mobile equipment fires through effective risk management supported by quality maintenance inspections, work execution, and a culture of ownership and care for your equipment.

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Deloitte acquired Bluefield Asset Management Specialists in November 2021. The Bluefield team continue to deploy their practical asset management knowledge and experience for clients as part of the Deloitte business

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Key Take-Aways

1. Most applicable mobile equipment fire risk management standards focus on fire protection, rather than fire prevention.
2. Effective fire risk management begins with identifying all fuel and ignition sources on the machine, then developing proactive fire prevention controls.
3. It is critical to document your equipment specifications, ensure they cover fire prevention, and keep them up-to-date.
4. PM service sheets must include fire prevention tasks with acceptable limits.
5. It does not matter how good the design is, nor the safeguards included in the equipment specification, if the maintenance is not executed adequately.

About the Author

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Partner, Specialist Asset

Gerard is an asset management professional with over 30 years' experience in all aspects of maintenance and reliability for both mobile and fixed plant mining assets, as well as leading an organization that has developed a solid client base in Transportation and Gas.

Gerard has worked in all roles from tradesperson to global practice leader for maintenance. His corporate experience has been across several large mining companies, including BHP Billiton, Rio Tinto, Peabody and Anglo and in many countries including Indonesia and Chile.

Over the past ten years, Gerard has helped a broad range of clients including small, medium, and large companies to improve their asset performance and bottom line.

Stephen Flannery
Partner, Specialist Asset

Steve is a seasoned Asset Management professional with over 30 years' experience leading the delivery of transformative business outcomes in heavy plant maintenance and major projects. Steve's consulting experience covers a broad range of clients and locations across Australia including mining - iron ore, open cut and underground coal and metalliferous, rail, ports and infrastructure.

Matthew Grant
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Matt is a mechanical engineer and asset management professional with over 20 years' experience in all aspects of maintenance and reliability. Matt is experienced in the design and implementation of ISO55000-aligned asset management systems, achieving external recognition for best practice in both processes and outcomes. Matt's ability to develop asset management systems is importantly complemented by his ability to ensure these systems can be practically implemented to deliver real business outcomes.

1.Introduction

1.1 Purpose

The purpose of this document is to provide examples for implementing management actions to prevent (not supress) mobile equipment fires.

AS5062:2016 Fire Protection for Mobile and Transportable Equipment is the applicable standard to follow. MDG 1032 is also a useful reference document.

AS5062 includes a section on Fire Risk Reduction. However, the essential actions to reduce the likelihood of a fire (Fire Prevention) are often not included or adequately considered in the risk assessments that have been reviewed.

This document is intended to assist sites to overcome this gap. It is not intended to provide any information related to fire suppression, which has been very well researched and actioned in other locations.

1.2 Intent

The intent of the document is to provide experienced based guidance or examples of methods to manage the four elements required to prevent mobile equipment fires (Figure 1-1).

These four elements are:

1. Equipment fire risk assessment and including fire prevention.
2. Subsequent to the risk assessment, the development of an equipment specification that includes fire prevention.
3. Subsequent to the equipment specification, the documented PM service inspection sheets; and most importantly
4. Quality execution of the PM inspections, maintenance repairs, and adequate and timely action to correct defects and substandard conditions.

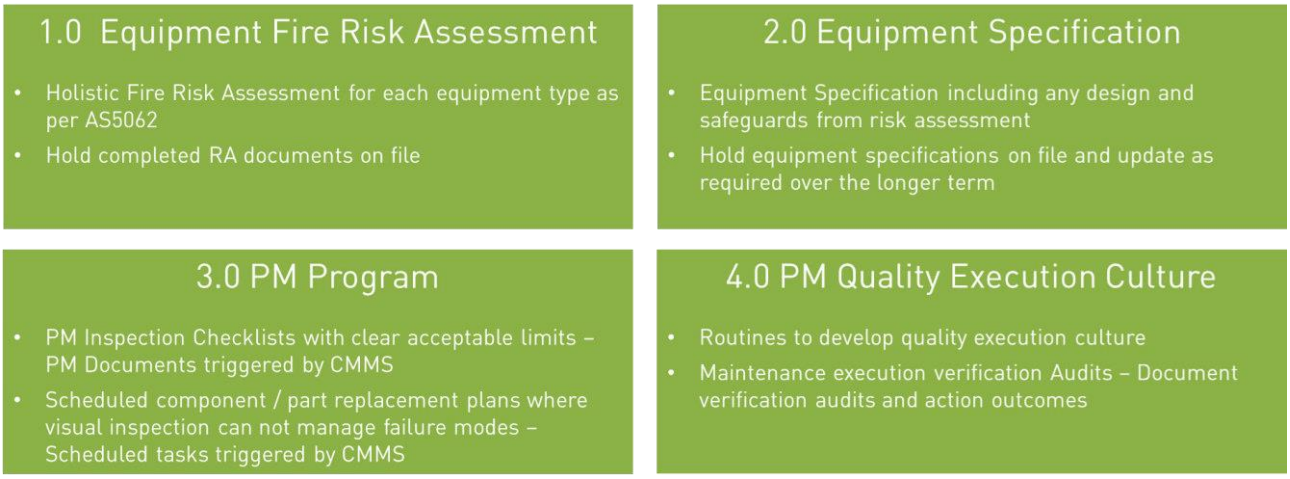


Figure 1-1 Four Management Elements

It is essential to note that Step 4— PM Quality Execution Culture will have the most impact on the prevention in the short term.

The risk assessments, specifications and PM documentation are important. However, good quality maintenance and inspections from a team of maintainers, with a culture of ownership and care for the equipment, will identify the sub-standard conditions and correct these before a fire can ignite.

2.Self-Assessment: Fire Risk Reduction

Use the self-assessment below to check your site's current performance against the requirements for managing mobile equipment fire risks.

Table 2-1 Self-Assessment: Fire Risk Reduction

Requirement	Points	Total
Have you completed a fire risk assessment for each type of mobile equipment on site?	Yes = 0 No = -10	0%
Do your risk assessments identify fire risk reduction actions in all areas (Physical safeguards and admin)	1 to 5	5%
Have the fire risk reduction actions been translated into your equipment specification documents?	1 to 5	5%
Do your PM checklists have clear acceptable limits for maintaining the equipment standards in a condition that will reduce the risk of fire?	1 to 10	10%
Do all areas identified in the risk assessment where a fire can start have maintenance checks in the PM checklists for the machine?	1 to 10	10%
Is there a deliberate mechanism on site to create the required culture of quality PM execution?	1 to 45	45%
Does the site perform self-audits of the execution quality and does the outcome influence the execution teams?	1 to 25	25%

3.Management Element One— Equipment Fire Risk Assessments

3.1 Key Outcomes

In addition to the fire suppression actions that arise from the risk assessment process, the equipment fire risk assessments need to consider fire prevention actions (Figure 3-1).

Many of the fire risk assessments only consider fire suppression and ignore more proactive fire prevention actions.

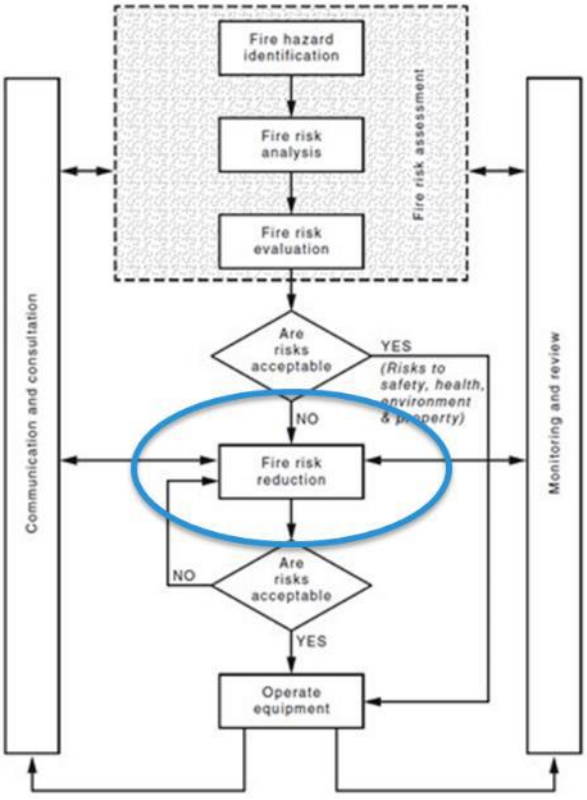


Figure 3-1 Fire Risk Assessment Process (Source: AS5062:2016)

3.1 Recommended Practices

A good mobile equipment fire risk assessment should identify all the fuel and ignition sources, and their locations on the machine. For example:

- Fuel sources: Diesel, Hydraulic oil, engine oil, build-up of foreign materials or coal, rubber, or plastic material
- Ignition sources: Turbo, exhaust, wiring, batteries, electrical components, brakes
- Locations: Engine compartment, brake areas, cab, hydraulic area, battery box, electrical compartment

The risk assessment will then quantify these risks and assign risk reduction actions.

Typically, the final task is to assign risk reduction actions, which usually only include fire suppression.

The following tables (Table 3-1, Table 3-2) show a completed fire risk assessment table, including fire prevention actions which the site should include in the risk assessments for each model of machine. They include both safeguards and administration controls.

Figure 3-2 also provides an example of the comprehensive risk assessment tool used by the Specialist Asset team.

Table 3-1 Example Fire Risk Assessment— Safeguards

Location	Description of Risk	Likelihood	Consequence	Potential Fire Risk Reduction— Safeguard Controls
Engine compartment	Hydraulic or fuel line ruptures releasing pressurised fuel onto hot components	Use Company-Specific Criteria		• Utilise shields on hoses which can spray combustible fluid onto hot components • Firewalls between engine and ignition sources • Consider possibility of non-combustible fluids • Ensure hose routing and clamping of adequate design to prevent wear out failure modes • Routing of hydraulic lines out of engine compartment • Full length hoses
Engine compartment	Build-up of fuel in area ignites on turbo, exhaust or other hot components			• Utilise heat shields on turbo and exhaust components • Consider waterjacketed turbos
Engine compartment	Electrical cable insulation fails and shorts causing ignition of residual fuels			• Ensure electrical cable is adequately mechanically protected use MDG15 as guide • Ensure electrical cable insulation material is suitable for high heat environment • Fuel refill away from ignition sources
Brake areas	Brakes dragging causes heat which ignites residual oils			• Use oil immersed braking systems • Hydraulic hoses secured with adequate clamping and security
Cab	Electrical cable insulation fails and shorts causing ignition of residual fuels			• Ensure electrical cable is adequately mechanically protected • Ensure electrical cable insulation material is suitable for high heat environment

Location	Description of Risk	Likelihood	Consequence	Potential Fire Risk Reduction— Safeguard Controls
Hydraulic areas	Hydraulic hose fails causing release of fluid that contacts ignition source			• Ensure hose routing and clamping of adequate design to prevent wear out failure modes. Use MDG15 guidelines and rout away from ignition sources • Fire resistant hoses • Refill areas away from ignition sources
Battery Box	Main battery cable insulation fails due to mechanical wear and shorts causing an ignition of the insulation and surrounding fuels			• Ensure electrical cable is adequately mechanically protected
Electrical compartment	Electrical hot connections cause ignition of insulation and surrounding fuels			• Install fusible links and circuit breakers (MDG15)
Electrical compartment	Component fails due to mechanical or insulation failure causing ignition of residual fuels			• Ensure battery box is able to be washed out easily, ventilated • Ensure battery box lid cannot short terminals • Ensure cables are mechanically protected

Table 3-2 Example Fire Risk Assessment (Admin Controls)

Location	Description of Risk	Likelihood	Consequence	Potential Fire Risk Reduction—Safeguard Controls
Engine compartment	Hydraulic or fuel line ruptures releasing pressurised fuel onto hot components	Use Company-Specific Criteria		• Ensure all PM checklists have clear acceptable limits for wear of hoses • Ensure hoses that have lost flexibility due to age or heat damaged are identified and replaced • Ensure all PM checklists have clear acceptable limits for leaks/weeps on hoses (Some hoses will have zero tolerance to leaks or weeps) • Ensure PM checklists state that any loose hose clamping should be corrected before hose wear starts
Engine compartment	Build-up of fuel in area ignites on turbo, exhaust or other hot components			• Ensure all PM checklists have clear acceptable limits for wear of hoses • Ensure hoses that have lost flexibility due to age or heat damaged are identified and replaced • Ensure all PM checklists have clear acceptable limits for leaks/weeps on hoses (Some hoses will have zero tolerance to leaks or weeps) • Ensure PM checklists state that any loose hose clamping should be corrected before hose wear starts
Engine compartment	Electrical cable insulation fails and shorts causing ignition of residual fuels			• Ensure PM checklists clearly state that worn cables or worn cable protection should be replaced
Brake areas	Brakes dragging causes heat which ignites residual oils			• Ensure brake areas PM inspections state that area must be cleaned and free of build up of combustible material
Cab	Electrical cable insulation fails and shorts causing ignition of residual fuels			• Ensure area PM inspections state that area must be cleaned and free of build up of combustible material • Inspect electrical cables in areas for mechanical wearsuitable for high heat environment

Location	Description of Risk	Likelihood	Consequence	Potential Fire Risk Reduction—Safeguard Controls
Hydraulic areas	Hydraulic hose fails causing release of fluid that contacts ignition source			• Ensure all PM checklists have clear acceptable limits for wear of hoses • Ensure hoses that have lost flexibility due to age or heat damaged are identified and replaced • Ensure all PM checklists have clear acceptable limits for leaks/weeps on hoses (Some hoses will have zero tolerance to leaks or weeps) • Ensure PM checklists state that any loose hose clamping should be corrected before hose wear starts
Battery Box	Main battery cable insulation fails due to mechanical wear and shorts causing an ignition of the insulation and surrounding fuels			• Ensure all PM checklists have clear acceptable limits for wear of hoses • Ensure hoses that have lost flexibility due to age or heat damaged are identified and replaced • Ensure all PM checklists have clear acceptable limits for leaks/weeps on hoses (Some hoses will have zero tolerance to leaks or weeps) • Ensure PM checklists state that any loose hose clamping should be corrected before hose wear starts
Electrical compartment	Electrical hot connections cause ignition of insulation and surrounding fuels			• Ensure PM checklists inspect for loose or hot electrical connections • Ensure electrical compartments are cleaned and free of combustible materials
Electrical compartment	Component fails due to mechanical or insulation failure causing ignition of residual fuels			• Ensure electrical components are inspected for integrity and signs of heating

Figure 3-2 Example of the Specialist Asset Comprehensive Risk Assessment

Scenario ID	Work Area Description	Hazard Type Description	Source/Ref	Guideline Sub Header	Hazard Description	Scenario Description	Impact Description	Operational Status Description	Scenario Owner Position	CURRENT CAUSES AND CONTROLS: Cause Description	CURRENT CAUSES AND CONTROLS: Control Comments (Summary of current controls) E=Eliminate, S=Substitution, I=Isolation, EN=Engineering, A=Administration, P=PPE, POST=Mitigation	CURRENT RISK (Risk based on current control in place): Consequence	CURRENT RISK: Likelihood	CURRENT RISK: Risk Rating	PREDICTED RISK (Risk evaluated based on future controls in place): Proposed Controls (Control Comments)	PREDICTED RISK: Consequence	PREDICTED RISK: Likelihood	PREDICTED RISK: Risk Rating	PREDICTED RISK: Responsible Person
E.G. 1	Wharf	Gravity	AS6799		Fall from Height	Fall during ship to shore transfer	Guy gets seriously hurt from fall	Normal operation	Port Superintendent	Human engineering - work environment	Types of controls in place, each control must be on a new line and start with type of control e.g.: A=procedures EN=Guarding	Serious	Unlikely	Moderate	EN=Install enclosed EN=level gangway	Minor	Rare	Low	Superintendent
1	994K Wheel Loader	Thermal	MDG15 4.4.2	Location of services access points within the engine compartment:	Fire - Surface - Mobile Plant	Machine thermal incident	Operator thermal injury egressing from cab Equipment damage	Normal operation	Manager, Maintenance	Machine engineering - base design Services (diesel/oil/etc) in the engine bay are a source of fuel for a thermal event Services are shielded but the shielding proves to be less-than-adequate	A=General Assumptions* - (Ref: Context Tab) A=Inspections during PM of OEM provided firewalls. EN=Exhaust components shielded (lagging). EN=Establish critical hose register that identifies hoses requiring additional protection due to operating function and environment EN=High Pressure Hyd hoses fitted with burst protection and recorded on register (OEM to provide register)	Minor	Almost Certain	Moderate	A=Consider implementing routine thermal imaging PM to identify and address hot spots EN=Consider additional lagging and/or dual skin pipework/exhaust to reduce ignition source hot spots A=Set expectation for wash crews regarding damage to lagging EN=Confirm adequacy of lagging material (reduce potential for Hydrocarbon contamination/impregnation)	Medium	Possible	Moderate	
2	994K Wheel Loader	Thermal	MDG15 4.4.2	Location of services access points within the engine compartment:	Fire - Surface - Mobile Plant	Machine thermal incident	Operator thermal injury egressing from cab Equipment damage	Normal operation	Manager, Maintenance	Machine engineering - base design Services (diesel/oil/etc) in the engine bay are a source of fuel for a thermal event Services are damaged in service during maintenance events - e.g.: less than adequate maintenance /installation	A=General Assumptions* - (Ref: Context Tab) A=Return To Work inspections - post Planned and Breakdown maintenance - documented process verified by Supervisor. (include running checks when replacing components to identify leaks etc). A=Return to Work inspections - post rebuild/major maintenance, including: field follow inspections within site designated timeframe after return to work. (Similar to planned retorque process)	Serious	Unlikely	Moderate	A=TNA's for maintainer and operator training packages to include requirements for quality inspections and repairs A=Review service sheets for inclusion of hold points for inspection quality checks.	Serious	Almost Certain	Critical	
3	994K Wheel Loader	Thermal	MDG15 4.4.3	Fuel and hydraulic	Fire - Surface - Mobile	Machine thermal	Operator thermal injury	Normal operation	Manager, Maintenance	Machine engineering -	A=General Assumptions* - (Ref: Context Tab)	Major	Almost	Critical	EN=Planned hose changeout strategy	Catastrophic	Rare	High	
4	994K Wheel Loader	Thermal	MDG15 4.4.3	Fuel and hydraulic circuits To assist in preventing the initiation of fires in the engine compartment:	Fire - Surface - Mobile Plant	Machine thermal incident	Operator thermal injury egressing from cab Equipment damage	Normal operation	Manager, Maintenance	Machine engineering - base design Diesel and hydraulic circuits provide fuel source for a thermal event Diesel tank caps leak (even when machine is level) providing a fuel source for a thermal event	A=General Assumptions* - (Ref: Context Tab) EN=Tanks located at centre of machine remote from hot surfaces. Overflow hoses directed towards ground EN=Multiflow fuel shutoff system installed *(verify fast fill rate) I=Engine shutdown during fuelling.	Catastrophic	Rare	High		Medium	Possible	Moderate	
5	994K Wheel Loader	Thermal	MDG15 4.4.3	Fuel and hydraulic circuits To assist in preventing the initiation of fires in the engine compartment:	Fire - Surface - Mobile Plant	Machine thermal incident	Operator thermal injury egressing from cab Equipment damage	Normal operation	Manager, Maintenance	Machine engineering - base design Diesel and hydraulic circuits provide fuel source for a thermal event Fluid filter housings are less-than-adequate and provide a fuel source for a thermal event	A=General Assumptions* - (Ref: Context Tab) EN=Metal body fuel filters, transmission filter is OEM after issues were seen at other sites.	Minor	Almost Certain	Moderate		Serious	Almost Certain	Critical	
6	994K Wheel Loader	Thermal	MDG15 4.4.4	Pipes and hoses When pipes and hoses fail, they release volatile fuels to make contact with hot surfaces resulting in fires for example from fuel or oil being sprayed onto the hot surface of a turbo charger	Fire - Surface - Mobile Plant	Machine thermal incident	Operator thermal injury egressing from cab Equipment damage	Normal operation	Manager, Maintenance	Machine engineering - base design Pipe and flexible lines fail providing a fuel source for a thermal event Diesel lines are manufactured from a material that is less-than-adequate for the application	A=General Assumptions* - (Ref: Context Tab) EN=Non OEM hoses made according to OEM part numbers. Hose design equivalent to OEM and match tested (MDG41). A=Specific inspections of fuel hoses. EN=Diesel: LP-hoses and HP-steel lines	Serious	Unlikely	Moderate		Catastrophic	Rare	High	
7	994K Wheel Loader	Thermal	MDG15 4.4.4	Pipes and hoses When pipes and hoses fail, they release volatile fuels to make contact with hot surfaces resulting in fires for example from fuel or oil being sprayed onto the hot surface of a turbo charger	Fire - Surface - Mobile Plant	Machine thermal incident	Operator thermal injury egressing from cab Equipment damage	Normal operation	Manager, Maintenance	Machine engineering - base design Pipe and flexible lines fail providing a fuel source for a thermal event Fluid- carrying pipes are manufactured from a material that is less-than-adequate for the application	A=General Assumptions* - (Ref: Context Tab) EN=hard piping has been utilised in the machine design wherever possible (significant increase in hard piping from previous models) EN=Non OEM hoses made according to OEM part numbers. Hose design equivalent to OEM and match tested (MDG41). A=Specific inspections of fuel hoses.	Major	Almost Certain	Critical		Medium	Possible	Moderate	

The screen shot is from a complete risk assessment. Specialist Asset has a comprehensive risk assessment toolkit available for use. Contact us for more information.

3.3 Useful data for the Risk Assessment

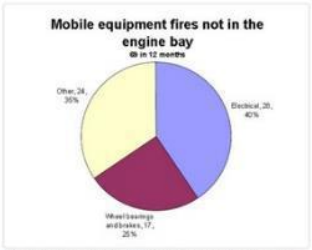
It is important to involve people in the risk assessments that have experience or have researched the fires that have occurred previously.

The fire starting today are due to the exact same causes as the fires starting on mobile equipment 15 years ago.

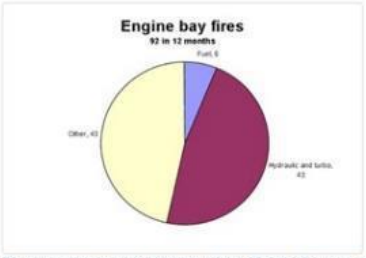
Queensland's DNRME can provide information to base these risk assessments as well can the sites themselves from their own safety incident databases.

The report with the link below provides some level of data analysis.

https://www.dnrme.qld.gov.au/business/mining/safety-and-health/alerts-and-bulletins/mines-safety/fires-on-mine-sites



Pie chart showing the 69 fires that occurred on mobile equipment but not in the engine bay



Pie chart showing the fire types of the 92 fires that occurred on mobile equipment in the engine bay

4.Management Element Two— Equipment

4.1 Overview

The equipment specifications need to be specific about the inclusions of items to prevent fires or reduce the risk of fire.

AS5062:2016 points to Design, Safeguards and Admin Controls.

The mining industry has little, if any, short term control over OEM designs.

- Safeguards (Mine pack) can include:
- Heat shields
- Burst shields
- Mechanical protection for electrical cables (MDG15)
- Hose routing and clamping
- Mechanical protection for hoses
- Non-flammable fluids
- Auto shutoff fuel filling systems

4.2 Recommended Management Actions

- Document and hold on file up to date equipment specifications for each model of machine on site.

- Ensure the equipment specifications include the specific requirements for fire prevention (fire risk reduction).
- Update equipment specifications when changes to design are made.
- Limit surface temperatures of components.

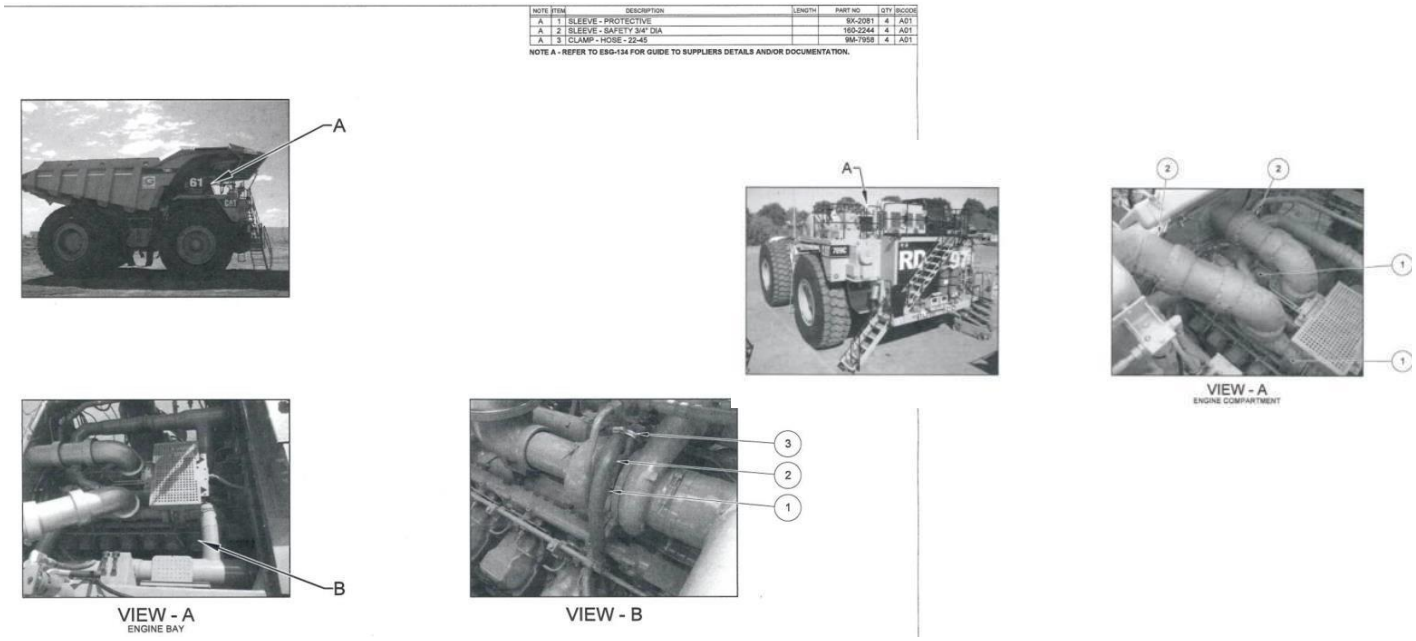
4.2 Recommended Management Actions

Typical inclusions for a truck technical specification:

1. General Requirements
2. Safety
3. Tyres and Rims
4. Machine Identification
5. Guarding
6. Painting
7. Electric System
8. Lubrication System
9. Fire Suppression System
10. Hose, Fittings and Clamps
11. Other Specific Requirements

Further examples can be found on the following page:

	E000-AA5554	1	FIRE PREVENTION COATING UNDER BONNET	std
	E000-AA5330	1	ENGINE BAY BONNET MODIFICATION	inc
Engine	E000-AA3115	1	TURBO OIL LINE SHEATHING (double layer sheathing)	std
	E000-AA5667	1	TURBO CHARGER HEAT SHEILDS (Mackay Turbo Repairs)	std



5.Management Element Three—PM Service Inspection Sheets

5.1 Overview

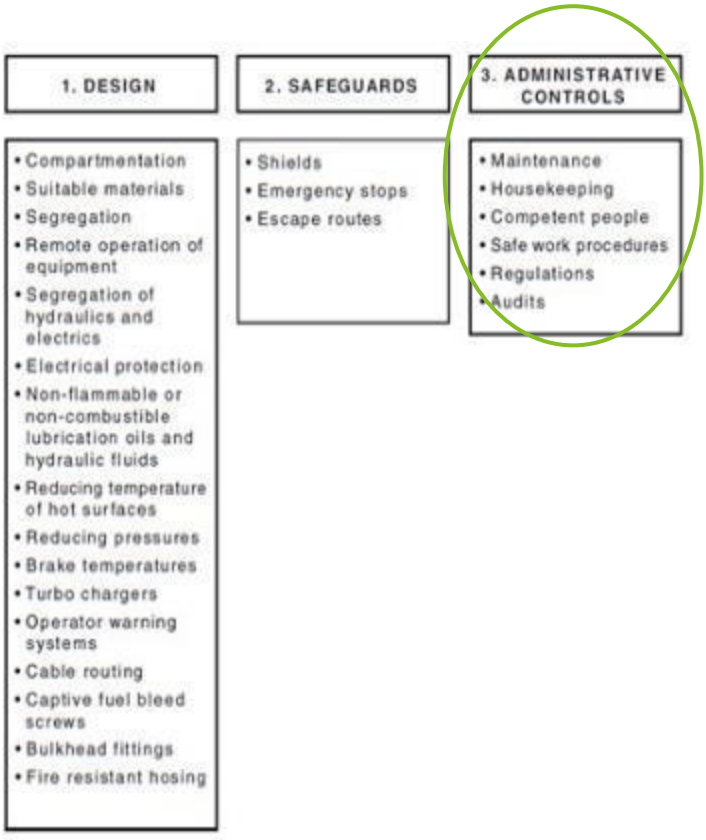
There is a requirement to produce PM inspection sheets that specify the standards to which the items included in the equipment specification must be maintained.

There is no requirement to double up on the inspections unless there is a culture of poor-quality inspections. Pre-Release inspections sheets after services are only implemented into sites where the original inspections are not done adequately and these pre-release sheets rarely if ever solve the problems.

Some items on the machine also require replacement frequencies, such as some hoses that get heat affected and can fail internally from becoming brittle. These failure modes cannot be monitored visually.

5.2 Recommended Management Actions

- Develop specific tasks in the PM checklists with clear acceptable limits for the areas of the machine and components, where the highest fire risks exist. E.g. engine compartment, battery box, electrical cabling etc.
- Develop specific tasks with clear acceptable limits for fire prevention equipment that is included in the equipment specification.
- Develop specific scheduled replacement tasks where failure modes cannot be detected through the inspections.



5.3 Scheduled Replacement Task Examples

Ensure that the PM program driven by the CMMS includes:

- Scheduled change out of specific hoses that can become brittle and fail from the inside out.
- Scheduled replacement of components that can develop internal shorts or failures which are unable to be condition monitored.

KOMATSU 830E REAR DUMP TRUCK 2000 HR

FIRE PREVENTION				
Turbochargers	Inspect turbo lube lines for condition, leaks, weeps, chaffing and security of clamps. *Acceptable limits:* *No visual damage, no weeps, securely fastened, no build up of combustible material*		Ok Faulty	
Fuel System	Inspect fuel hoses and pipes adjacent to exhaust components for condition, leaks, chaffing and security of clamps. *Acceptable limits:* *No visual damage, no weeps, securely fastened*		Ok Faulty	
Electrical System	Inspect the batteries and battery box components for security and integrity. Check battery terminal connections and cable security inside battery box. Check cable condition and security where they pass through the battery box. *Acceptable limits:* *No visual damage or loose connections / clamps. Mechanical protection in place*		Ok Faulty	
	Inspect jump receptacle and isolator cables for integrity, chaffing and security. Ensure connections are tight and clean. *Acceptable limits:* *No visual damage, securely fastened*			
	Inspect starter motor, prelube and alternator cables for condition, chaffing and security. Ensure connections are tight and clean. *Acceptable limits:* *No visual damage, securely fastened*		Ok Faulty	
	Ensure correct function of battery isolator. *Acceptable limits:* *All equipment is de-energised when battery is isolated*			

Brakes - Rear	Inspect the brake hoses for condition, leaks, chaffing and security of clamps. *Acceptable limits:* *No visual damage, no weeps, securely fastened*		Ok Faulty	
	Inspect the disc and calipers for signs of dragging or excessive heat. *Acceptable limits:* *No visual damage or sign of excessive heat, no build up of combustible material*		Ok Faulty	
Exhaust Shields and Lagging	Inspect condition and security of all exhaust lagging and shielding fitted to machine *Acceptable limits:* *No visual damage, securely fastened, no gaps, no absorbed flammable fluids*		Ok Faulty	

Equipment – Engine/Hydraulic/Fuel

Item	Compliant Yes/No/NA	Comments
Turbo lagging in place secure and free from oil or other combustible material		
Fuel lines secure and installed as much as possible away from ignition sources		
Hydraulic lines secure and installed as much as possible away from ignition sources		
Hydraulic lines have burst protection where there is a risk of oil from the burst hoses coming in contact with hot services		
Hydraulic piping is secure and free from leaks		
Hydraulic valve banks secure and free from leaks		
Engine free from oil leaks and clean		
Hydraulic system free from leaks that could pose a risk and clean		
Physical barriers are in place to direct any potential spray of burst hydraulic systems away from hot surfaces and major electrical components		

6.Management Element Four— Quality Execution Standards

6.1 Overview

It does not matter how good the design is or the safeguards included in the equipment specification if the maintenance is not executed adequately.

Execution includes the physical execution of the task and the close out of the job and raising of subsequent tasks in the maintenance management system (Figure 6-1).

If subsequent tasks from inspections are not raised in a system and tracked to completion, then the inspection time is effectively wasted.

Not all defects can be fixed immediately once found.

Only critical defects must be fixed immediately, and the site should ask themselves how they did not identify this defect earlier, why does it have to be fixed immediately.

Quality work execution standards cannot be achieved through documents, they come through the culture of the organisation.

6.2 Recommended Management Actions

- Incorporate deliberate work routines that will create the required culture.
- Perform work execution quality audits or evaluations to ensure the work routines are effective.

6.2 Developing a Quality Work Execution Culture

Quality of work is something that must be part of the culture of the organisation. All people performing work must be on the same page and adopt the same standards to be successful.

Implement deliberate routines that can develop a quality work culture within the organisation:

- Quality discussion board at shift start
- Improvement action board at shift start
- Failed parts bin for discussion at shift start

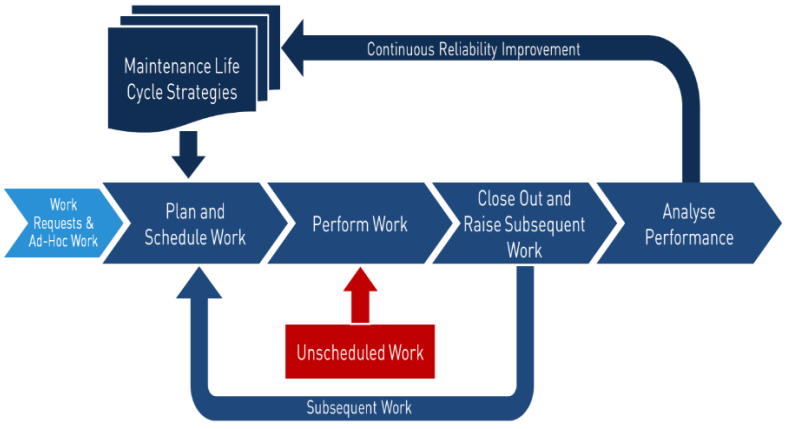


Figure 6-1 Work Management Model

6.4 Example— Quality Discussion Board

The board (Figure 6-2) is used to raise awareness across crews of the acceptable standards by sharing and discussing examples of good performance and examples of poor performance

It is possible to discuss poor performance in a positive manner not to shame people but to agree as a team to acceptable standards

The sheets can also all be held in one display sheet on the wall with each crew list on the communication. Once all crews check off the list it can be removed.

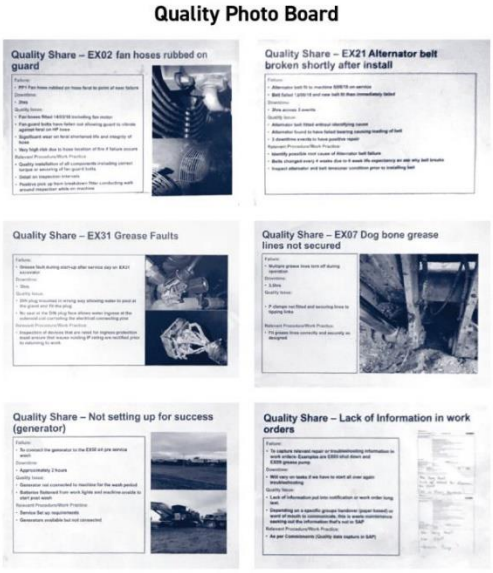


Figure 6-2 Quality Discussion Board

6.5 Example— Improvement Action Board

Action	Date Raised	Who Responsible	Due date / Status	Date Completed
Not all of the people have access to SAP. Get list of people without access and provide access	14/10/2019	D. Smith	In progress. Due for completion by 24/12/2019	
The small tool and consumables trailer is continually out of bolts. Need to setup a contents list and review/restocking process. Need all crews to complete it at the end of each swing.	2/09/2019	J. Brown	Content developed. Need all crews to agree on once per rotation review and restocking.	

6.6 Example— Failed Parts Bin

Discussing the failed parts with the execution teams each morning can provide great learning in terms of quality.

One example of this was from a site where they had a fuel line failure. The responders put the fuel line in the failed parts bin. When they reviewed it, they found it had failed at a point that had previously been temporarily repaired (braised). This repair was temporary, but no-one had raised a subsequent work order to fix it permanently (lacking positive fix culture).

They checked other machined and found the same thing on other machines. This was a powerful learning for the team and enabled them to understand why they were having so many breakdowns and remove the cause of this.

Many similar examples of hoses that failed and were clearly able to be monitored visually helped to change the culture of accepting sub-standard hose conditions.

6.7 Role of Leadership

Leadership needs to create an environment where people can discuss problems openly and when the processes are not followed correctly, we need to understand compliance requires continual discussion and reminding.

The quality boards and action boards will only provide ongoing benefit if the leadership ensure the tools are used. Eventually it will become the culture but initially it requires leadership drive.

Leaders need to look at the machines regularly and critically assess the machine condition and how this relates to the PM inspection sheets being completed.

Leaders also need to realise that if a current checklist or document is not achieving the intended outcome then creating another document does not fix the problem, it just makes more admin work to do.

6.7 Performing Work Quality Audits

Work quality audits need to be completed on a regular basis (superintendent and supervisor go look see).

Reviewing the equipment after a PM inspection and sharing the learning is a simple way to do this.

Reviewing completed PM checklists can also provide insights to the quality of the execution. E.g. many areas left blank, everything ticked, and no defects found are signs of lack of diligence in executing inspections

For more information, read our article
Speed up Defect Elimination and Reliability Improvement by Keeping Failed Parts.

About the Specialist Asset team

Recently merging with Deloitte on 1 November 2021, Bluefield was established in 2010. Since inception the company has grown to over 80 staff and included offices in Brisbane, Hunter Valley, Adelaide, Perth, Chile (Santiago), Canada (Toronto), and Finland.

The team provide specialist and practical services to asset-intensive industries. We service small to large companies and contractors, and pride ourselves on our ability to deliver results.

We have experience in Australia, Africa, Europe, Asia and the Americas and we prefer to build long-term mutually beneficial relationships with our clients.

Our services include:

- Asset Management Strategies & Planning
- Analysis & Optimisation
- Project Management & Delivery
- Process Reviews & Improvement
- Maintenance & Reliability Improvement
- Asset Health & Integrity Support
- Training & Leadership Support
- Specialist Advice and Support

Deloitte.