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Australia



Fire prevention and protection for mobile and transportable equipment



AS 5062:2022

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- Mining Electrical and Mining Mechanical Engineering Society

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Fire prevention and protection for mobile and transportable equipment

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Preface

This Australian Standard was prepared by Standards Australia Committee FP-022, Fire Prevention and Protection for Mobile and Transportable Equipment, to supersede AS 5062:2016, *Fire protection for mobile and transportable equipment*.

The objective of this document is to formalize current good practice in reducing the incidence and severity of fires and to provide a consistent approach to fire risk reduction in order to safeguard life, property and the environment against fire associated with mobile and transportable equipment. A prevention focus has been adopted in this revision to reflect this.

Providing protection against fire on mobile and transportable equipment poses unique and specific challenges, which general risk assessment methodologies do not necessarily address. This document is intended to assist in meeting those specific requirements.

The major changes in this edition are as follows:

- (a) An increased emphasis on fire prevention.
- (b) Addition of new test requirements to prove repeatability of fire extinguishing performance testing within [Appendix E](#).
- (c) Inclusion of a table to define fire testing requirements for different types of fire systems.
- (d) Inclusion of summary information on the common types of fire extinguishing agents used in mobile and transportable equipment, see [Appendix A](#).
- (e) Addition of a new requirement for listing of detection devices.
- (f) Addition of surface temperature and fuel ignition temperature assessment.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

This document includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the document.

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Australian Standard®

Fire prevention and protection for mobile and transportable equipment

Section 1 Scope and general

1.1 Scope

This document specifies fire risk management procedures, fire prevention measures and the minimum requirements for fire-protection system design, installation, commissioning, and maintenance for use on mobile and transportable equipment. This document details requirements for pre-engineered fire systems. It also details requirements for fire-protection systems to be listed and for the fire testing of foam-water spray systems.

While engineered systems may be, and are, used for the protection of mobile and transportable equipment, the requirements for appropriate design concentrations, or application density of extinguishing agents are not covered by this standard.

NOTE 1 Refer to the relevant Australian or International Standard for the engineered system in question. To ensure engineered systems are suitable for use on mobile and transportable equipment they should be subjected to endurance testing specified in [Appendix D](#) or equivalent.

This document applies to mobile and transportable equipment in the following industry sectors:

- (a) Surface and underground mining.
- (b) Quarrying.
- (c) Forestry.
- (d) Waste management.
- (e) Construction.
- (f) Railway.
- (g) Agriculture.
- (h) Defence.
- (i) Ports.

Mobile and transportable equipment includes the following commercial and recreational vehicles:

- (A) Buses.
- (B) Four-wheel drives.
- (C) Road haulage.
- (D) Motor homes.
- (E) Forklifts.
- (F) Road registered plant.
- (G) Cranes.

This document is intended to apply to new equipment but may be applied to existing equipment.

NOTE 2 For existing equipment, the fire risk assessment may identify the need for further risk reduction measures or modification of existing reduction measures, see [Section 3](#).

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the reference document (including any amendments) applies.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1210, *Pressure vessels*

AS 1319, *Safety signs for the occupational environment*

AS 1851, *Routine service of fire protection systems and equipment*

AS 1890, *Thermally released links*

AS 2030.1, *Gas cylinders, Part 1: General requirements*

AS 2067, *Substations and high voltage installations exceeding 1 kV a.c*

AS 2331.3.1, *Methods of test for metallic and related coatings Method 3.1: Corrosion and related property tests—Neutral salt spray test (NSS test)*

AS 2444, *Portable fire extinguishers and fire blankets—Selection and location*

AS 2473.1, *Valves for compressed gas cylinders, Part 1: Specifications, type testing, and manufacturing tests and inspections*

AS 2613, *Safety devices for gas cylinders*

AS 2700, *Colour standards for general purposes*

AS 2706, *Numerical values—Rounding and interpretation of limiting values*

AS 4343, *Pressure equipment—Hazard levels*

AS 4487, *Condensed aerosol fire extinguishing systems—Requirements for system design, installation and commissioning and test methods for components*

AS 60529, *Degrees of protection provided by enclosures (IP code)*

AS/NZS 1841.1, *Portable fire extinguishers, Part 1: General requirements*

AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 3100, *Approval and test specification—General requirements for electrical equipment*

AS/NZS 3788, *Pressure equipment — In-service inspection*

AS/NZS 4024.1204, *Safety of machinery — Electrical equipment of machines, Part 1204: General requirements (IEC 60204-1:2016 (ED. 6.0) MOD)*

AS/NZS 4024.1603, *Safety of machinery, Part 1603: Design of controls, interlocks and guards — Prevention of unexpected start-up*

AS/NZS 4024.1604, *Safety of machinery, Part 1604: Design of controls, interlocks and guarding — Emergency stop — Principles for design (ISO 13850:2015 (ED.3.0) MOD)*

AS/NZS 61000.6.2, *Electromagnetic compatibility (EMC), Part 6.2: General standards—Immunity for industrial environments*

AS/NZS 61000.6.4, *Electromagnetic compatibility (EMC), Part 6.4: Generic standards—Emission standard for industrial environments (IEC 61000-6-4:2018 (ED 3.0) MOD)*

AS ISO 13766 (all parts), *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 3864-2, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

IEC 60068-2-2, *Environmental testing, Part 2.2: Tests—Test B: Dry heat*

IEC 60068-2-6, *Environmental testing, Part 2.6: Tests—Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing, Part 2.27: Tests—Test Ea and guidance: Shock*

UL 1254 Edition 6, *Pre-engineered dry and wet chemical extinguishing system units*

FM APPROVAL 5970. *Heavy Duty Mobile Equipment Protection Systems*. 2020

SP Method. 4912. *Testing of fire suppression system intended for use in compartment with combustion engine*. Edition 2, 2019

1.3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

1.3.1

approved

accepted by the relevant authority

1.3.2

baseline data

data, either provided by or derived from, the approved design and commissioning thereof, which, when and where provided, serves as a basis for verification of the results of routine servicing

1.3.3

competent person

person who has acquired through education, training, qualification or experience, or a combination of these, the knowledge and skill enabling that person to perform the task required

1.3.4

container

cylinder or other vessel used to store the extinguishing agent

1.3.5

defects and non-conformance

1.3.5.1

critical defect

defect that renders a system inoperative

Note 1 to entry: A critical defect is reasonably likely to have a significant adverse impact on safety.

1.3.5.2

non-critical defect

system impairment or faulty component not likely to critically affect the operation of the system

1.3.5.3

non-conformance

missing information or incorrect features that do not affect the system operation but are required to facilitate ongoing routine service

EXAMPLE Missing baseline data.

1.3.6

directional valve

device for controlling the passage of the extinguishing agent from a supply manifold to pre-selected areas of protection

1.3.7

distribution system

pipework and fittings downstream of a container

1.3.8

effective discharge time

period of time between the first appearance of extinguishing agent from the system discharge nozzles and the time when the discharge changes from predominantly extinguishing agent to propellant

Note 1 to entry: The end of the effective discharge is often accompanied by a characteristic change in the sound and appearance of the discharge.

1.3.9

electrical clearance

air distance between system equipment, including piping and nozzles, and unenclosed or non-insulated live electrical components

1.3.10

engineered system

fire-suppression system consisting of a supply of extinguishing agent connected to pipework where the quantity of agent and the size of each section of pipe and nozzle orifice has been hydraulically calculated to deliver the required quantity of agent from each nozzle

1.3.11

extinguishing system unit

identified components that are to be assembled into a system for the discharge of an extinguishing agent through fixed piping or hose, and nozzles for the purpose of extinguishing fires

1.3.12

fire-suppression system

system to suppress or extinguish a fire by either local application or total flood design methodology

1.3.13

hazard

source of potential harm or a situation with a potential to cause loss

1.3.14

listed

equipment, materials, manuals, systems or services included in a list published by an organization that is acceptable to the relevant authority

Note 1 to entry: The listing includes evaluation of products or services, and the maintenance of periodic inspection of production or listed equipment or materials or periodic evaluation of services and whose listing states that either the equipment, material, or service meets appropriate designated Standards or has been tested and found suitable for a specified purpose.

Note 2 to entry: Examples of recognized testing and approval bodies are laboratories accredited by NATA or other ILAC member organization, and JAS-ANZ accredited conformity assessment (certification) bodies such as CSIRO ActivFire, Factory Mutual (FM), Loss Prevention Certification Board (LPCB), SP Technical Research Institute of Sweden, Underwriters Laboratories (UL) or Verband der Schadenverhütung (VdS).

1.3.15**local application system**

fire-suppression system arranged to discharge the extinguishing agent directly onto the burning material or identified fire hazard location, without the need for an enclosure to establish an effective concentration of extinguishing agent

1.3.16**lock-off device**

manual device installed in the discharge piping downstream of the agent containers which, when closed, mechanically prevents agent reticulation into the protected area

1.3.17**manual**

requiring human intervention to accomplish a function

1.3.18**may**

indicates the existence of an option

1.3.19**mobile equipment**

machine capable of being readily moved while in operation

Note 1 to entry: Mobile equipment includes trucks, tractors, excavators and drills.

Note 2 to entry: Mobile and transportable equipment are generally referred to as “equipment” in this document.

1.3.20**normally unoccupied space**

area not normally occupied but which people may enter occasionally for brief periods

1.3.21**owner**

person or organization that has the legal rights to a particular piece of equipment

Note 1 to entry: Where the equipment is leased or financed such that the legal rights to the equipment are maintained by the finance company and the finance company has no interest in the operation of the equipment, then the owner is the person or organization that pays the finance company and/or has an option to purchase the equipment at the end of the lease or finance period.

1.3.22**pre-engineered system**

fire-protection system consisting of a supply of extinguishing agent of specified quantity coupled to a pre-calculated pipework with nozzle up to a maximum permitted limit

Note 1 to entry: No hydraulic calculations are required to size pipework or nozzles.

1.3.23**relevant authority**

agency authorized by legislation or regulation to issue determinations, orders, or other instructions in respect of any subject covered by this document

EXAMPLE Minister of the Crown; government department; other public authority having power to issue regulations, orders or other instructions having the force of the law in respect of any subject covered by an Australian Standard; or in cases where none of these apply, the owner or the owner's agent.

1.3.24**risk**

chance of an occurrence of an event that will have an impact upon objectives

1.3.25**shall**

indicates that a statement is mandatory

1.3.26**should**

indicates a recommendation

1.3.27**supervised**

continuous monitoring of the operational integrity or status of an electrical, mechanical, pneumatic or hydraulic feature of a system

1.3.28**survey**

visual inspection to identify if fire-protection systems or equipment have been altered, damaged or compromised

1.3.29**total flooding system**

fire-protection system arranged to discharge extinguishing agent into an enclosed space to achieve the appropriate design concentration

1.3.30**transportable equipment**

equipment designed to be periodically moved to a new position between periods of operation

EXAMPLE

Pumps, generators, lighting towers, drills, high wall augers, and mobile crushing plants.

Note 1 to entry: Mobile and transportable equipment are generally referred to as “equipment” in this document.

1.3.31**visual warning device**

device that is illuminated or otherwise rendered visible at the appropriate time

1.3.32**warning notice**

permanently visible warning sign associated with the system

1.4 Interpretation of specified limiting values

Values specified in this document shall be rounded in accordance with AS 2706. That is, the observed or calculated value is to be rounded to the same number of figures as in the specified limiting value of [2.5](#), 2.50 and 2.500, the observed or calculated value would be rounded, respectively, to the nearest 0.1, 0.01 or 0.001.

Section 2 Fire risk management

2.1 General

2.1.1 Design objective

Fire risk management shall be focused on prevention of fire in the first instance. Across the lifecycle of any equipment, the design shall aim to eliminate situations that can lead to a fire, considering fault conditions or occurrences of probable human error. The design shall establish the boundary conditions for the environments in which the equipment is designed to operate. The design shall also define the purpose and functions that the plant is designed to perform.

The design shall achieve the function of the equipment while minimizing the risk of fire, throughout all stages of its lifecycle. The design shall aim to eliminate potential ignition sources that could become actual ignition sources when contacted by any fluid or material used, accumulated or deposited on the equipment during —

- (a) normal operation;
- (b) expected malfunction;
- (c) reasonably foreseeable misuse; or
- (d) reasonably foreseeable human error.

NOTE Reasonably foreseeable lifecycle events, human error or misuse incidents may be documented by regulator safety alerts and bulletins, standards, notifications from end users and experience from repair workshops and tradespersons.

2.1.2 Fire risk management process

A fire risk management process is the systematic application of management policies, procedures and practices to identify, analyse, control, monitor and review fire risks at all phases of equipment life.

The fire risk management process shall be carried out in accordance with [Figure 2.1.3](#).

NOTE 1 Refer to AS/NZS 4024.1201 for guidance on fire risk management processes.

The fire risk management process shall include the following stages:

- (a) Fire risk assessment —
 - (i) fire hazard identification;
 - (ii) fire risk analysis; and
 - (iii) fire risk evaluation.
- (b) Fire risk reduction (treat risks).
- (c) Fire risk monitoring and review.

The fire risk management process should be an integral part of the organization's occupational health and safety management system and should include a continuous improvement process, see AS/NZS ISO 45001.

NOTE 2 For further information, refer to NSW Resources Regulator's guidance material and Minerals Industry Safety and Health Risk Management Guidelines.

Consultation shall be carried out at each stage of the fire risk management process in accordance with [Clause 2.2](#).

C2.1.2 *Phases of equipment life include the following:*

- (a) *Design.*
- (b) *Construction/acquisition.*
- (c) *Installation, assembly and commissioning.*
- (d) *Operation, including start-up and shutdown.*
- (e) *Maintenance, including breakdown, planned and preventive maintenance.*
- (f) *Modification.*
- (g) *Decommissioning and dismantling.*

2.1.3 Risk assessment**2.1.3.1 General**

A risk assessment shall be carried out —

- (a) when equipment is designed;
- (b) prior to equipment being placed into service; and
- (c) when variations in design, use condition and environment could change the fire risk potential.

2.1.3.2 Process

The fire risk assessment shall be structured as follows:

- (a) Determine the possible fire scenarios:
 - (i) What can happen?
 - (ii) When and where can it happen?
 - (iii) Why and how can it happen?

NOTE 1 See [Clause 2.4](#) for fire hazard identification.
- (b) Quantify the risk exposure by determining the likelihood and consequence of the fire scenarios:
 - (i) How likely is this to happen?
 - (ii) What are the consequences?

NOTE 2 See [Clause 2.5](#) for fire risk analysis.
- (c) Prioritize fire risk — what risk needs to be addressed first?

NOTE 3 See [Clause 2.6](#) for fire risk evaluation.

[Figure 2.4.1](#) sets out the fire risk assessment process.

2.1.3.3 Methods

Risk assessment methods shall be used to analyse the fire risk. Methods may include:

- (a) Consequence analysis.
- (b) Fault tree analysis (FTA).
- (c) Event tree analysis (ETA).
- (d) Failure modes effects analysis (FMEA).
- (e) Human error analysis (HEA).
- (f) Workplace risk assessment control (WRAC).
- (g) Hazard analysis (HAZAN).
- (h) Hazard and operability study (HAZOP).

NOTE 1 More than one method may be required to identify all fire risks.

NOTE 2 AS 4024.1201 and AS/NZS 4024.1302 provide guidance on methods that may be suitable.

NOTE 3 Further information is available in Joy and Griffiths, *National Minerals Industry Safety and Health Risk Assessment Guideline*.

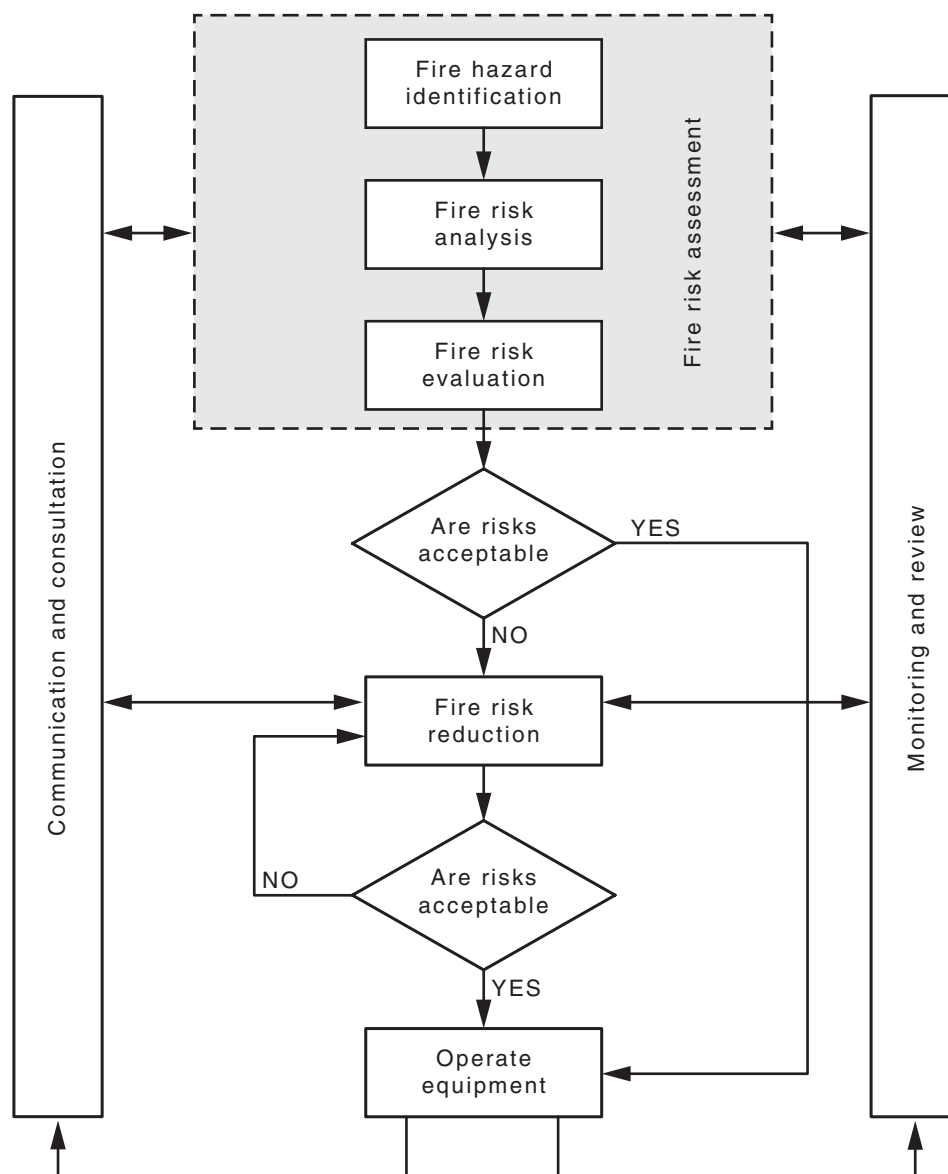


Figure 2.1.3 — Fire risk management process

2.1.4 Fire incidents

Previous fire experiences on similar equipment should be identified and the findings assessed at each stage of the fire risk management process.

C.1.3 Past experience may indicate that special hazards exist, such as equipment that has an adverse fire history or component failure that increases fire potential. Such a list of fire incidents should be maintained to inform risk management process. Further information is available from:

- (a) NSW Resources Regulator: <https://www.resourcesregulator.nsw.gov.au/safety/health-and-safety-management/fires-on-mobile-plant-safety>
- (b) Resources Safety and Health Queensland: <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/hazards/hazards>
- (c) WA Department of Mines, Industry Regulation and Safety: <https://www.dmp.wa.gov.au/Safety/Guidance-about-addressing-some-6398.aspx>

(d) *Earth Moving Equipment Safety Round Table: <https://emesrt.org/equipment-fires/>* (continued)

2.2 Consultation

The fire risk-management process shall be conducted by and involve competent persons. Examples of such persons include:

- (a) Owner.
- (b) Operator.
- (c) Maintenance personnel.
- (d) Manufacturer's representative.
- (e) Supplier.
- (f) Hirer.
- (g) Insurer.
- (h) Specialist fire consultant.

Fire hazards and risks associated with mobile and transportable equipment are often too complex to be fully understood by one person. Therefore, consultation regarding the fire hazards identified and risk reduction methods taken should be undertaken with at least three parties from the list above. These consultations should consider the operation and maintenance of the protected equipment and the fire system.

A risk assessment shall be completed. Any control measures identified in the risk assessment shall be implemented.

2.3 Records

The fire risk-management process shall be fully documented for the life of the equipment. Records shall be maintained, including those associated with —

- (a) hazard identification, risk analysis and risk evaluation;
- (b) risk reduction methods;
- (c) consultation;
- (d) maintenance;
- (e) accidents, incidents and safety statistics; and
- (f) monitoring and review.

2.4 Fire hazard identification

2.4.1 General

A fire hazard exists where there is the potential for interaction between fuel sources, oxygen and ignition sources. Fire hazards shall be identified in accordance with the process set out in [Figure 2.4.1](#).

The risk assessment shall identify the impact of changes in material properties over time or with use. Such changes may include the possibility of deterioration of the material, resulting in an increased fire risk.

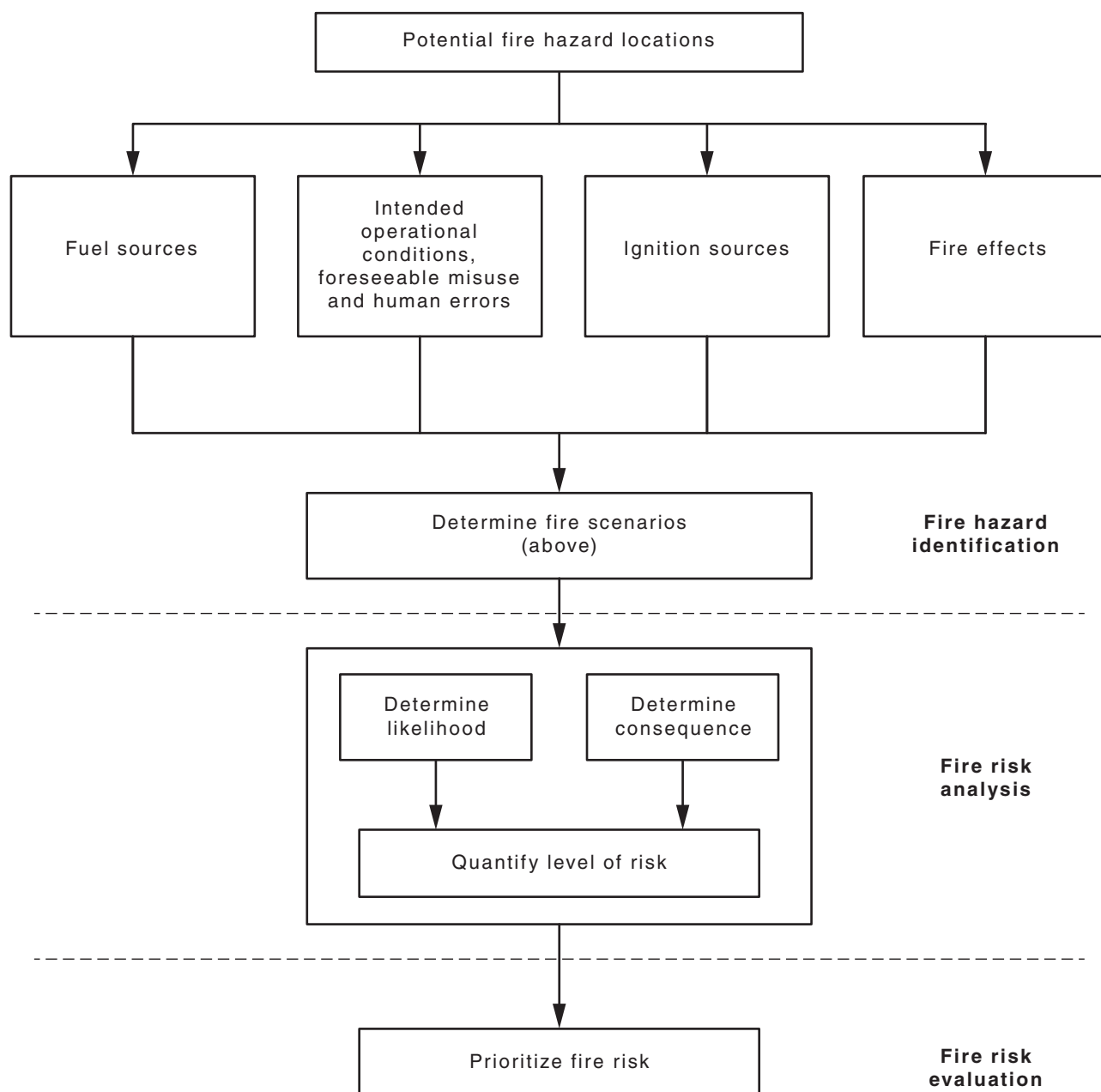


Figure 2.4.1 — Fire risk assessment

2.4.2 Fuel sources

2.4.2.1 General

When assessing the fire hazard location, all fuel sources shall be identified, including —

- (a) primary fuel sources such as flammable liquids and lubricant;
- (b) materials of construction of the equipment;
- (c) the product being processed or transported; and
- (d) the surrounding environment.

2.4.2.2 Types

Fuels to be identified may include those associated with the following classes of fire:

- (a) *Class A* — Fires involving carbonaceous solids, which normally burn under the formation of glow.

EXAMPLE Wood, textiles, rags, paper, rubber, electrical insulation or conduit, coal or flammable dust, construction materials, upholstery, hoses, tyres, seats, combustible debris and many plastics.

- (b) *Class B* — Fires involving flammable and combustible liquids.

EXAMPLE Diesel, petrol, hydraulic fluid, grease, lacquer, resin, tar, ether, alcohol, oils and some coolant combinations.

- (c) *Class C* — Fires involving combustible gases.

EXAMPLE LPG, methane, propane and hydrogen.

- (d) *Class D* — Fires involving certain combustible metals.

EXAMPLE Magnesium, aluminium, lithium, sodium, potassium and their alloys.

- (e) *Class E* — Fires involving electrically energized equipment.

EXAMPLE Fires in battery-powered equipment.

2.4.2.3 Properties

The properties of the fuels shall be identified and include the following:

- (a) Ignitability.
- (b) Flammability.
- (c) Combustibility.
- (d) Quantity and continuity of supply.
- (e) Toxicity and combustion products.
- (f) Environmental impact of fire effluents.

NOTE Where the fire properties of materials cannot be found in technical literature or the fuel's Safety Data Sheet, appropriate testing of the materials or components may need to be carried out.

2.4.3 Oxidizers

When assessing the fire hazard, the existence and quantity of fire supporting substances and the probability of their occurrence shall be determined.

C2.4.3 *The most common oxidizer is air but there are other oxidizers that support combustion, e.g. ammonium nitrate.*

2.4.4 Ignition sources

When assessing the fire hazard, all ignition sources shall be identified, including the following:

- (a) Thermal energy.

EXAMPLE High temperatures and hot surfaces are usually found in the vicinity of internal combustion engines, exhaust systems, pumps, turbochargers, batteries, wiring, switches, electric motors, generators, heat exchangers, bearings and brakes.

(b) Electrical energy.

EXAMPLE Switch gear, motors, electric dynamic retarders, transformers, batteries, lights, cables, short circuit and electric arc, earth or conductor fault, discharge of static electricity, loose contact and induction heating.

(c) Mechanical energy.

EXAMPLE Welding and cutting, friction, overheating, impact, and grinding.

(d) Chemical energy.

EXAMPLE Chemical reaction, self-heating, self-ignition, and runaway exothermic reaction including thermal runaway of large battery systems.

2.4.5 Potential fire hazard locations

Particular fire hazard locations associated with equipment shall be identified and may include the following:

- (a) Turbo chargers.
- (b) Fuel systems, including piping, hoses, pumps valving and injectors in close proximity to ignition sources.
- (c) Cooling system, including hydraulics, engine and transmission.
- (d) Exhaust systems.
- (e) Hydraulics systems, including piping, hoses, pump and valving.
- (f) Lubrication systems, including engine and transmission systems and grease systems.
- (g) Braking systems, including retarders, park brakes and service brakes.
- (h) Electrical systems, including alternators, generators, batteries, wiring and switch gear.
- (i) Battery/Energy storage systems, including thermal runaway.
- (j) Locations where combustible materials can accumulate.

EXAMPLE Belly plates, engine valleys and wheel arches.

(k) Tyres.

(l) Tyre filling compounds.

NOTE 1 Potential fire hazard locations may be remote from the fuel or ignition source, for example, a liquid can spray or drip onto a hot surface remote from the leak point.

NOTE 2 An electrical short conductor may transfer heat to another area of the equipment.

NOTE 3 Fires involving tyres represent a significant safety hazard due to the potential for explosive deflation.

2.4.6 Operating environments

The risk assessment shall include risk factors attributed to the operating environment.

Particular fire hazard operating environments associated with the equipment include situations where the equipment fire will impact on the environment (e.g. forests/bushfires), or the environment will

impact on the equipment. Fire hazards associated with the operating environment may include the presence of —

- (a) combustible dust (e.g. coal);
- (b) combustible gases;
- (c) timber;
- (d) confined spaces;
- (e) oil spills;
- (f) fuel and waste dumps/depots;
- (g) tyre storage areas; and
- (h) high temperature.

2.5 Fire risk analysis

2.5.1 General

The fire risk on equipment shall be determined by analysis in accordance with [Figure 2.4.1](#).

NOTE Additional information on risk analysis is given in [Appendix B](#).

2.5.2 Fire risk determination

2.5.2.1 General

The fire risk analysis shall determine the risks for the following, where applicable:

- (a) Health and safety of people operating or in the vicinity of the equipment.
- (b) Property loss.
- (c) Production loss.
- (d) Environmental damage.

2.5.2.2 Fire effects

The risk analysis shall include the following effects of fire:

- (a) Fire propagation.
- (b) Thermal radiation.
- (c) Products of combustion (e.g. smoke, toxic gases).
- (d) Escaping materials into the surrounding area (e.g. pine forests).
- (e) Fire effluent.

2.5.3 Operational conditions

The risk analysis shall take into account the potential for operational conditions to increase the fire risk. Such operating conditions may include the following:

- (a) Operating environment.

EXAMPLE Unshot ground, road conditions, road gradients, equipment speeds, gases and build-up of combustible materials.

- (b) Time of day.
- (c) Equipment use and misuse.

EXAMPLE Park brake being left on, brakes dragging, and emergency brakes used as service brakes.

- (d) Wear and tear of components.
- (e) Life cycle of components.

EXAMPLE Hoses deteriorating, hoses and electrical cables rubbing and electrical conduit deteriorating.

- (f) Equipment interaction.

EXAMPLE Refuelling and collisions.

- (g) Inexperienced use of equipment.
- (h) Human error, such as poor maintenance practices.

EXAMPLE Rags left in engine compartment, removal of oils and greases, re-routing of hoses and modifications, housekeeping, use of incorrect materials, cleaning, changes of wiring and circuitry.

2.5.4 Existing risk controls

The fire risk analysis shall include analysis of existing controls, such as:

- (a) Paths of normal and emergency egress for operations personnel.
- (b) Means of fire detection, e.g. visual.
- (c) Availability of portable extinguishers.
- (d) Availability of fire-fighting personnel, external support and response time.
- (e) Procedures and training in use of equipment.

2.6 Fire risk evaluation

The fire risk evaluation shall compare fire risks with acceptance criteria as determined by the organization responsible for the safe operation of the equipment. Priorities for further actions and fire risk reduction (treatment) shall be established.

If the results of the risk evaluation indicate an unacceptable level of risk exists, then fire risk-reduction measures shall be undertaken in accordance with [Section 3](#). The residual risk shall be acceptable to the organization responsible for the safe operation of the equipment.

2.7 Monitoring and review

The fire risk management process shall be a continuous improvement process. It shall be monitored and reviewed —

- (a) periodically at intervals not exceeding five years;
- (b) whenever changes are made to the equipment that could affect the fire risk;
- (c) whenever variations in use, condition or environment could change the fire risk potential;

- (d) when there is a change of owner; and
- (e) after fire accidents or incidents occur.

Section 3 Fire risk reduction

3.1 Risk identification and assessment

3.1.1 General

An assessment of the equipment with regard to fire risk should be conducted during the design process to allow for additional controls identified to be incorporated into the original machine design. This assessment should be conducted in accordance with [Section 2](#).

This assessment should include a review of fuel and ignition sources such as flammable and combustible fluids, non-metallic combustible materials used in the construction, combustible materials which may accumulate on the plant during use, and hot surfaces. Risks related to electric and hybrid mobile and transportable equipment should also be considered.

NOTE See [Clause 2.1.3.3](#) for suitable risk assessment methods.

3.1.2 Risk reduction hierarchy

When additional measures are required to manage the risk of fire, they should be implemented following the hierarchy of fire risk reduction set out in [Figure 3.1.2](#). Design or engineering measures should be used to eliminate or minimize fire hazards.

The residual risk after the implementation of controls, safeguards or fire-protection measures shall be documented to inform owners and users of the plant. The risk reduction measures described in [Figure 3.1.3](#) should be considered at each level of the hierarchy.

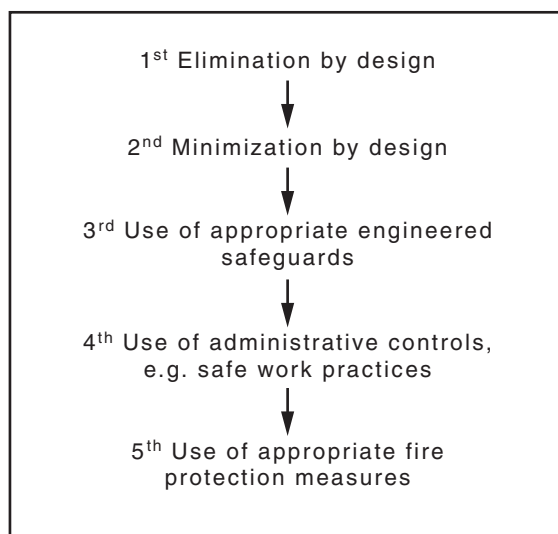


Figure 3.1.2 — Hierarchy of fire risk reduction

3.1.3 Introduction of further risk

When assessing additional risk control measures, any changes to equipment should not introduce other potential hazards that increase risk. Hazards can include —

- (a) obstruction of access and egress;
- (b) obstruction of vision;
- (c) changes to equipment that impact operating conditions;

- EXAMPLE Air flow, heat load.
- (d) introduction of materials that create new risks;
- EXAMPLE Flammable or toxic materials.
- (e) obstruction of equipment controls and maintenance points;
- (f) adverse effects of extinguishing agent; and
- EXAMPLE Use of electrically conductive fire extinguishing agents on energized electrical equipment or fire extinguishing agents denser than air having a potential to cause asphyxiation.
- (g) compromised integrity of safety systems.
- EXAMPLE Control systems and functionality, operator protective structures.

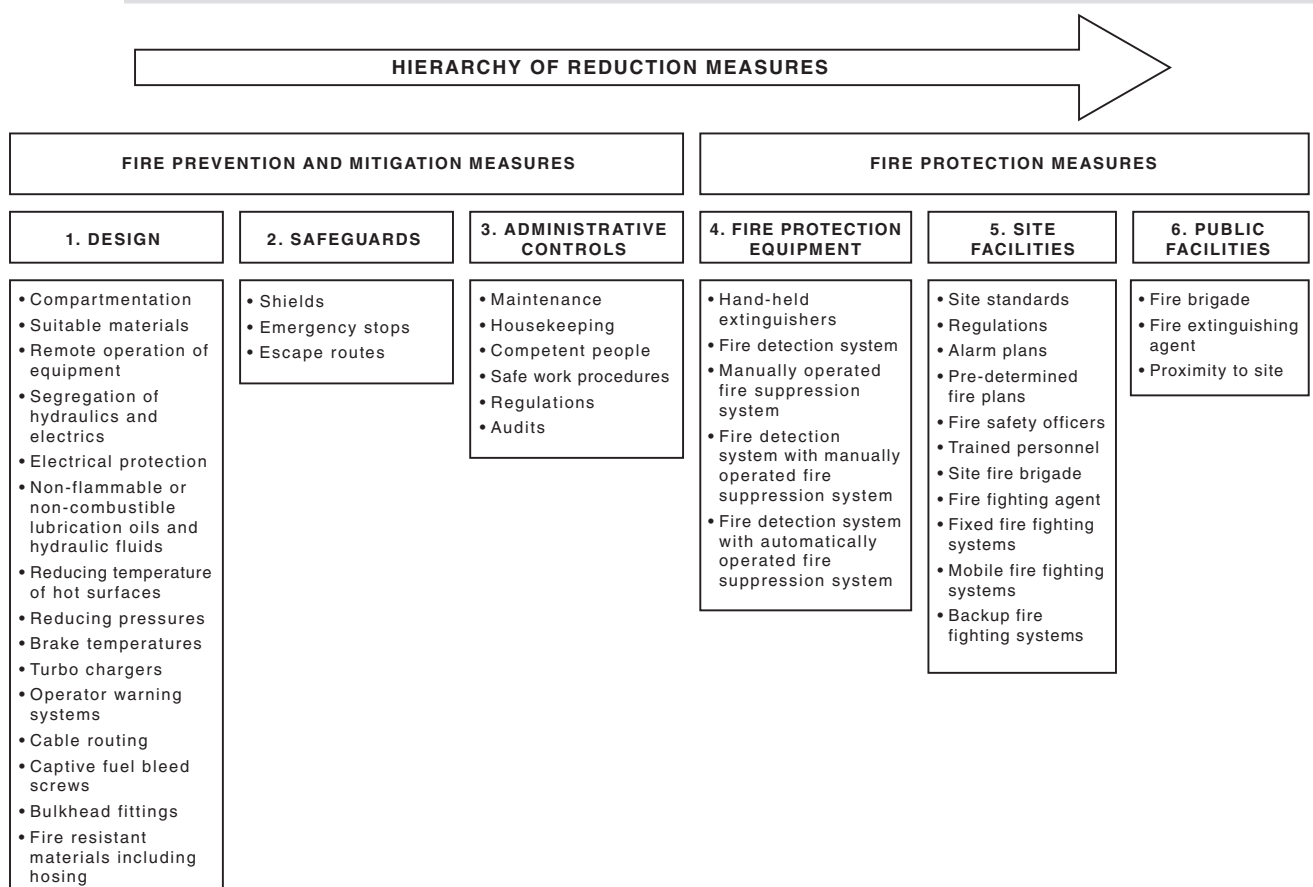


Figure 3.1.3 — Fire risk reduction measures

3.2 Design measures and safeguards

3.2.1 General

The operational conditions under which mobile and transportable equipment are operated shall be documented.

EXAMPLE Operating temperatures, hazardous environments and industry sector.

Any modifications made to the original design should be carried out in consultation with the manufacturer.

3.2.2 Ignition sources

3.2.2.1 General

Design for fire risk reduction shall assess and implement design measures to reduce the risk related to ignition sources, including high surface temperatures.

3.2.2.2 Surface temperatures

Temperature of surfaces that present a risk of contact with fuel sources should be assessed for risk of ignition, taking into account —

- (a) fluid spray and fuel leakage contacting the surfaces;
- (b) surface temperatures measurement outlined in [Clause 3.2.10](#);
- (c) surface temperatures measurement documented in the residual fire risks information outlined in [Clause 3.5](#);
- (d) comparison of the ignition temperature of the fuel with the temperature of the contacting surface;

NOTE The 2013 literature review of RR980 Page 55 by the UK Health and Safety Executive suggests surface temperatures should not exceed 60 °C above the auto-ignition temperature to prevent fire.

- (e) surface overheating from scenarios outlined in [Clause 3.2.5](#); and
- (f) consideration given to the ambient temperature of the intended operating environment.

3.2.2.3 Design measures

Design measures for the control of ignition sources should include the following:

- (i) Controls to limit temperature of surfaces that present a risk of ignition of fuel. Fixed and permanent controls such as double-walled components and water jacketing should be used instead of temporary protection such as blanket-type lagging and wrapping, where practicable.
- (ii) Use of correctly rated interlocks to prevent misuse of components that have a high risk of generating a fire.

EXAMPLE Park brake interlock to propulsion or retardation.

- (iii) Use of protection devices for electrical circuits.

EXAMPLE Circuit breakers, fuses, current limiting devices.

- (iv) Use of correctly rated electrical circuits.
- (v) Use of extra-low voltage wiring that takes into account AS/NZS 4024.1204, where applicable.
- (vi) Protection of electrical cables and components against mechanical damage.
- (vii) Design of electrical connections such that they cannot loosen or overheat under normal conditions of service.
- (viii) Covering, mechanical protection and securing of batteries and cables to prevent short-circuiting.
- (ix) Adequate ventilation of battery enclosures.
- (x) When a hybrid or electric power system is fitted, the additional electrical ignition points.

(xi) Wiring —

- (A) using suitable mechanical protection;

EXAMPLE Guards, sheathing, conduits or glands to prevent ingress of fuel sources and contaminants.

- (B) using bulkhead fittings or glands, where electrical conduits penetrate enclosures or partitions;
- (C) installed and routed clear of hot surfaces or radiant heat; and
- (D) arranged so as to facilitate regular visual inspections.

3.2.3 Fuel sources

Design for fire risk reduction should assess all flammable and combustible solid, liquid, aerosol and gas fuel sources.

Design measures for the control of fuel sources should include the following:

- (a) Potential consideration of leaks, weeps or sprays from any fluid conductor.
- (b) Segregation of fuel sources from ignition points such as fire walls and location of tanks containing flammable or combustible liquids.
- (c) Use of fuel with reduced flammability or increased auto ignition temperatures.
- (d) Use of materials of construction (or operation of the equipment) that are non-combustible, non-flammable or have reduced combustibility or flammability.

EXAMPLE Fuel tanks, non-metallic covers and guards.

- (e) Automatic shutoff for shutdown of fuel supply, as soon as practicable, e.g. fuel, hydraulic oils, coolant. Impact on other machine critical systems (i.e. braking and steering systems) should be considered.
- (f) Position of breathers and vents for operational and emergency venting.
- (g) Maximum operating angles to prevent combustible fluid loss from storage tanks. The discharge of breathers and vents should be positioned so as not to create additional fire risk.
- (h) Battery and electric drive power systems and components.

NOTE 1 Where a non-metallic fuel tank is used, refer to ISO 21507.

NOTE 2 Where sound suppression materials are used, they should be made of a material which does not absorb liquids, is fire resistant or made of a non-combustible material.

3.2.4 Hoses and piping

Design measures to be taken into account for liquid fuel sources shall include the following:

- (a) Segregation of hoses and piping from ignition points.
- (b) Use of metal pipes or metal-braided hoses where appropriate.
- (c) Use of hoses and pipes that are correctly rated for their application.
- (d) Use of hoses and fittings that conform to recognized Standards.
- (e) Use of fire-resistant hose to suit its location.

NOTE 1 Standards for fire resistance of hose include testing to ISO 8030 with an average glowing not exceeding 30 s, or Type 1 or Type 3 hose as detailed in ISO 6801.

- (f) Routing of hoses away from hot surfaces and to avoid heat exposure that may lead to deterioration.
- (g) Use of adequate clamping of hoses and pipes taking into account durability, vibration during operation and susceptibility to damage during maintenance.
- (h) Use of dual walled piping to suit its location.
- (i) Use of shields where hydraulic hoses may be damaged by impact, e.g. in wheel arch areas and under the body.
- (j) Routing of pipes and hoses in a manner that will provide mechanical protection against wear and damage, including when passing around or through structure.

NOTE 2 Refer to the NSW Resources Regulator's MDG 41 for additional guidance.

3.2.5 Overheating

Overheating, caused by foreseeable abnormal operating conditions resulting in an ignition source, shall be assessed and includes the following scenarios:

- (a) Brake drag and overuse, including retard systems.
- (b) Tyre overloading.

NOTE 1 Use of tyres with an appropriate tonne kilometres per hour (TKPH) rating for the intended duty.

- (c) Engine and hydraulic system overheating.
- (d) Mechanical failure e.g. bearings.
- (e) Electrical overloading including battery and hybrid systems.

NOTE 2 Overheating should be alerted to the operator within the machine.

3.2.6 Segregation

Segregation of fuel and ignition sources should be considered as a design measure for fire risk reduction and include the following:

- (a) Separating electrical cabling from hydraulic and fuel hoses.
- (b) Routing of hydraulic and fuel hoses away from high-risk ignition sources such as the turbocharger and exhaust pipework.
- (c) Routing of services including hydraulic lines, oil lines and electric power cables outside the engine compartment.
- (d) Use of shields to protect ruptured services from spraying onto potential ignition sources.

EXAMPLE Protection of supply hoses of hydraulically driven fans to prevent any oil spraying from a ruptured hose being blown onto hot surfaces.

- (e) Use of guards and shields to segregate fuel and ignition sources.
- (f) Use of firewalls to separate fuel and ignition sources

EXAMPLE Engine and hydraulic compartment.

NOTE 1 Firewalls should be designed not to interfere with compartment ventilation.

NOTE 2 See [Appendix C](#) for further guidance.

3.2.7 Accumulation of combustible or flammable materials

Areas where fuel can accumulate should be eliminated. Areas to be considered as a design measure for fire risk reduction include the following:

- (a) Within the structure such as belly pans, chassis members and platforms.
- (b) Sound attenuation material.
- (c) Lagging and heat blankets.
- (d) Machine components such as engine valleys and swing motors.

NOTE Known fires have occurred where fluids spray, accumulate and run, such as from a failed hose/pipe external to the engine bay that sprays fluid, which is then drawn into areas containing ignition points.

3.2.8 Reduction of fire effects

Machine design should consider the consequential impact of fire. This includes reducing impacts from flames, heat and smoke. Consideration should be given to the following:

- (a) Containing the fire by use of covers, shields or guards constructed from fire resistant material.
- (b) The use of effective shielding of the operator compartment.
- (c) Provision of safe egress from the machine.
- (d) The placement of large volume fuel tanks, vents and reliefs and where they vent and drain to.

3.2.9 Egress

The impact of fire should be considered for the design of operator primary and secondary egress from the machine. This should include walkway material selection, proximity to anticipated fuel and fire locations and probable human error during emergency situations.

NOTE Refer to AS 5327 for further considerations related to egress systems for earthmoving plant.

3.2.10 Surface temperature testing and measurement

High surface temperatures can present an ignition point for flammable liquids and sprays. Surface temperature measurements should be —

- (a) measured when the engine, transmission and machine fluids are at normal operating temperatures;
- (b) measured by a thermal image camera, thermocouple or contact probe;
- (c) measured with the permeable guards or shields removed where necessary;
- (d) measured with consideration to the emissivity for the surface material; and
- (e) provided with measurement of the ambient temperature; and
- (f) provided to relevant parties to manage fire risks.

3.3 Operation and maintenance

3.3.1 Maintenance and housekeeping

3.3.1.1 Maintenance

Maintenance works shall be carried out in accordance with the original equipment manufacturer's specifications and taking into account the operating environment and application. Maintenance shall include the necessary measures to maintain controls identified in the fire risk assessment.

Inspections to be included during maintenance include the following:

- (a) Damage or deterioration of hoses, wiring or mechanical components.
- (b) Missing or ineffective hose clamps.
- (c) Operational state and condition of fire detection and suppression system.
- (d) Missing, damaged or poorly fitted lagging or guarding.
- (e) Commissioning and testing following maintenance.

Maintenance practices and systems of work shall also include commissioning to verify the equipment is fit to return to work following maintenance activities. This is to ensure that any systems disturbed during the maintenance have been returned to a serviceable condition, that leaks are detected and that all systems function as intended, etc.

NOTE Fires have occurred as a result of human error and organisational factors during maintenance activities, including the installation of O-rings, clean up of spilt oil or diesel and installation of heat shields that don't meet the requirements of relevant standards.

3.3.1.2 Defect management

A defect management system should be implemented in order to identify and manage defects on equipment that may increase fire risk. The criticality of defects should be checked to assess if the equipment can continue to operate. Where a designed preventative measure is missing or ineffective, this should be considered a defect and should be assessed and actioned.

3.3.1.3 Accumulation of combustible or flammable materials

During operation and maintenance, combustible materials such as rubbish, oily rags, coal, timber, lubricants and leaks shall not accumulate and create a fire hazard.

Non-flammable consumables such as contact cleaner and degreasers should be used.

Areas where combustible or flammable material can accumulate shall be inspected and maintained. They include:

- (a) Operators cabins and access and egress areas.
- (b) Engine bay.
- (c) Within the structure such as belly pans, chassis members.
- (d) Sound attenuation panelling.
- (e) Lagging and heat blankets.
- (f) Machine components such as engine valleys, swing motors.

NOTE Poor housekeeping practices have resulted in the development of the fuel source for machine fires.