

	FIRE PREVENTION CRITICAL RISK CONTROL STANDARD	Document ID	TNCL-OHSS-STD-0012
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FIRE PREVENTION CRITICAL RISK CONTROL STANDARD (TNCL-OHSS-STD-0012)





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APPROVALS



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1. INTRODUCTION

1.1 Purpose of the Standard

This standard underpins Tembo Nickel safety vision that “every person goes home safe and healthy everyday” by proactively managing risks associated with identified Fatal/Critical Risks through the development and implementation of standards. This standard applies to all Tembo Nickel exploration, development, construction, operation, closure sites, and areas under Tembo Nickel’s control.


The purpose of this standard is to eliminate the potential for fatalities, injuries, and incidents arising from risks related to Fire operations. Fire work and activities have been identified by Tembo Nickel as one of our Fatal Risks. This Fatal Risk Standard has been developed by evaluating industry best practices and our own learnings from fatalities and serious injuries. The critical controls that are identified in this Fatal Risk Standard are the minimum requirements that shall be in place and implemented in conjunction with the Tembo Nickel’s Risk Management Standard to ensure that the risks are effectively controlled. This standard and supporting documents detail the minimum controls that shall be implemented and may be supplemented by procedures at the site level. Procedures implemented at the site level may include local or regional statutory requirements or site-specific requirements based on infrastructure or specialized equipment.

Any intended deviation from the requirements set forth in this Fatal Risk Standard shall be formally requested and approved through the following steps:

1. A detailed motivation is drafted clearly describing why the requirements of this standard are inappropriate in the specific circumstances and/or why and how the risks associated with the requirements can be otherwise mitigated.
2. A detailed, multi-disciplinary risk assessment is conducted detailing which alternative control measures are prescribed to adequately address the fatal risk.
3. A formal approval is obtained from the Chief Operating Officer confirming that the alternative control measures adequately control the fatal/critical risk and that any risk that may remain is understood, tolerable for the organization, and in line with Tembo Nickel's Journey to Zero harm.


1.2 Scope of the Standard

This Standard applies to all Tembo Nickel Employees, Contractors, Consultants and all service providers at Tembo Nickel Premises and all operational sites.


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2.TERMS AND DEFINITIONS

Term / Definition	Description
Risk	The combination of the probability of a fire incident occurring and the magnitude of its consequences to people, assets, the environment, and operations.
Critical Risk	Is a risk that has the potential to result in a catastrophic event causing one or more fatalities, permanent disabilities, major environmental damage, significant asset loss, or severe business interruption if not effectively controlled.
Critical Risk Control	Is a specific measure, safeguard, or barrier that is essential for preventing a critical risk event from occurring or for mitigating its consequences should the event occur.
Fire	A rapid oxidation process in which a chemical reaction results in the evolution of light, gases, and heat energy varying in intensity.
Fire Detection System	The combination of Fire Alarm detectors; Systems and Fire detectors.
Fire Alarm System	A system or portion of a combination system that consists of components and circuits arranged to monitor and announce the status of a fire condition or of supervisory signal- initiating devices in order to initiate the appropriate response to those signals.
Smoke Detector	An automatic device designed to detect the presence of smoke and initiate action.
Fire Detector	An automatic device designed-to detect the presence of a fire and initiate action.
Fire Prevention Measures	Actions deemed necessary and suitable to inhibit the initiation of a fire or stop the evolution of a developing fire.
Fire Protection Measures	Actions deemed necessary and suitable to safeguard the life and health of individuals and or the integrity of equipment, machinery and infrastructure that may be exposed to a fire.
Fire Suppression System	A system designed to enable total flooding by or for the localized application of extinguishing agents.
Flame	The visible portion of the fire.
Flame Retardant	A self- extinguishing substance or material that will inhibit the formation or the spread of a flame on a surface to which it is applied.
Fire Hazard"	A condition that presents the potential for harm to people and damage to property, or the environment because of fire.
Mine	A place where valuable minerals, metals, coal, or other geological materials are extracted from the earth for commercial purposes.
Hot Work	Work involving burning, heating, welding, grinding or a similar operation that is capable of initiating fires or explosions.

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EN-1568 SERIES	European standard that specifies the requirements and performance testing for firefighting foam concentrates used on flammable liquid fires. The standard evaluates the chemical, physical, and fire performance characteristics of foam.
ISO 14520 SERIES	Is an international standard that specifies the requirements for the design, installation, testing, inspection, maintenance, and safety of gaseous fire suppression systems used to protect buildings, industrial facilities, electrical rooms, control rooms, data centers, and other critical assets. The standard applies to clean gaseous extinguishing agents that leave no residue after discharge.
ISO 7202 SERIES	Is an international standard that specifies the requirements for dry chemical fire-extinguishing powders used in portable extinguishers, wheeled extinguishers, and fixed fire protection systems. It defines the chemical and physical properties, performance requirements, test methods, and manufacturer information for fire-extinguishing powders.
ISO 80079 SERIES	Is a family of international standards that specifies requirements for equipment, systems, and components used in explosive atmospheres where flammable gases, vapours, mists, or combustible dusts may be present.
NFPA	National Fire Protection Association, an organization that develops fire, electrical, and life-safety standards used throughout the world.
LPG	Liquefied Petroleum Gas - a fuel used for cooking, heating, and vehicles.
IFSTA	International Fire Service Training Association.
OSHA	Occupational Safety and Health Authority.
TNCL	Tembo Nickel Corporation Limited.
Mine	As defined in the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) as amended.
OEM	Original Equipment Manufacturer.
EWURA	Energy and Water Utilities Regulatory Authority.

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3 FIRE PREVENTION MEASURES


Fire Prevention Measures and systems in use and measures to confine fires at Tembo Nickel Includes:

- Portable fire extinguishers
- Audible emergency alarms
- Automatic fire suppression systems
- Fire Trail
- Fire Hose Reels
- Reef Blowers
- Water Tanks

4 RISK MANAGEMENT

4.1 Risk Assessment

Tanzania Health and Safety Act requires that an employer identifies hazards, assesses health and safety risks to which its employees may be exposed while at work, and records the significant hazards identified and risks assessed through the Baseline Risk Assessment.

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The matrix, as illustrated in Table below, is used to calibrate the various inputs and to provide for consistent rating of the risks. The risk-rating illustrated in Table 2: may be used by the Tembo Nickel's Mine for qualitative risk assessments.

Table 2 has probability of occurrence on the horizontal axis and severity of consequences on the vertical axis. The descriptions of consequences in each of the categories of safety, health, environment, legal and societal are set out opposite the consequence class in each case.

A risk rating is obtained by firstly reaching consensus on the probability of occurrence of a chain of events and then on the worst consequence from a safety, health, environmental, legal or societal point of view. The risk rating is then obtained by the intersection of the probability and consequence in the matrix.

Risks are rated in the following categories (Table 3):


- a. Catastrophic
- b. High
- c. Medium
- d. Low
- e. Tolerable

Catastrophic-Risk situations are defined as those which cannot be tolerated under any circumstances and for which immediate emergency action is required. This level of risk is taken in the most serious light, e.g. when unacceptable levels of flammable gas are detected all persons should be evacuated from the underground excavations pending instruction from management that the working place has been made safe for entry.

High-Risk are those that require immediate attention but do not necessarily imply emergency action. Time should normally be made available to plan and implement mitigation measures.

Medium to Low-Risk constitutes a flag for attention by management. This type of risk may be tolerated on an ongoing basis provided steps are taken to ensure that the only consequence would be financial and that any adverse impact could be readily remedied.

The Tolerable-Risk category represents all sources of risk that do not require any further attention. Although these risks do exist, they are highly unlikely to manifest themselves and therefore require no further detailed attention other than continuous monitoring.

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4.2 Risk Management Process.

The risk management process shall consider three broad types of risk assessments:

- **Baseline Risk Assessment. [Qualitative or Quantitative]**

A Baseline Health Risk Assessment shall be conducted for all new operations. However, for existing operations, a Baseline Risk Assessment shall be reviewed as prescribed, and where necessary, followed by Issue-Based or Continuous Health Risk Assessment.

- Issue Based Health Risk Assessment.

As circumstances and needs arise, the Issue Based Health Risk Assessment studies shall be carried out when:


- For specific operation tasks and/or activities.
- A system of work has changed, or operations has altered.
- After an accident/ incident or 'near-miss related to thermal stress has occurred; or
- New knowledge comes to light, and information is received which may influence the level of risk to Employees at the TNCL Mine.

The Issue Based Health Risk Assessment shall be associated with the system for the management of change.

- **Continuous Health Risk Assessment (Operational Risk Assessment)**

This form of risk assessment shall take place continually as an integral part of pre-task Hazard identification and safe declaration procedure. Continuous Health Risk Assessment shall be conducted by any person prior to start of any task and shall take place in the form pre-task Hazard identification and safe declaration. A formal training shall be provided to enable this process to be efficient. Examples of Continuous Health Risk Assessment shall include but not limited to:

- Inspection and Audits,
- General Hazard awareness linked to a suggestion scheme; and
- Pre-work assessments using checklists, e.g. an on-going Critical Task Plan Task Analysis and Planned Task Observations, etc.

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4.3 Risk Management

The following management action is mandatory for risks in each of the following categories:

- Catastrophic Risk: Emergency action.
- High Risk: Incident report and urgent action.
- Medium Risk : Flag for attention, mitigation, and continuous monitoring.
- Low risk: Action taken when reasonably possible, continuous monitoring.
- Tolerable Risk: No immediate action. Continuous improvement and continuous monitoring.

High risk situations should not be tolerated and should be avoided by proactive intervention. Senior management attention is needed to situations that approach the high-risk category.

- **Risk Analysis Method.**

The risk analysis considered all the tasks conducted in surface and underground workings.

- **The risk analysis included:**


- a. Description of the task/system under analysis.
- b. Evaluation of each risk by determining the probability of recurrence and severity of each event.
- c. Evaluation of current and planned controls, barriers and safeguards.

- **Determination of Levels of Risk.**

Risks associated with each step of the mining operations was considered, paying special attention to hazards and risks associated with the required fitness of persons performing the required tasks.

The following factors were considered and rated in accordance with the effect it would have on the items described below, should the event occur:

- a. Threat to the health and safety of a worker.
- b. Severity of the event.
- c. Likelihood of the event happening.
- d. Event consequence.

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- **Evaluation of Results.**

Activities listed in the high-risk categories must be seen as tasks requiring immediate attention. Training will, in most instances, solve the problem satisfactorily. An implementation plan may then be devised to address the outstanding issues. This action plan must take cognizance of the hazards that should be eliminated concurrently.

Risks and impact assessments will be reviewed when the following occur:

- Accidents.
- Disasters.
- Unforeseen circumstances.
- Changes occur in management, structures, operations, procedures, mining and ventilation layouts, etc.
- Environmental emergencies.
- Fatalities or lost time injuries.

All risk and impact assessments will be revised at least yearly by the risk assessment team.

- **Task specific risk assessment.**

Should the Baseline Risk Assessment or Issue Based Risk Assessments indicate tasks in High risk, a task/activity-based risk assessment must be conducted. This assessment will then target the specific tasks and the hazards attached to it.


- **Minimizing the Risks.**

The following programs are in place:

- Entry Examination.
- Safe Declaration.
- Training and Education.
- Competency Certification.
- Periodic Review of Standards and Procedure.

- **Monitoring**

A program of continuous risk assessment has been implemented to monitor all risks. Line Management, Consultants and Health and Safety Representatives conduct continuous risk assessments.

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4.4 Information Used to assist to Compile Risk Assessments

To assist the employer with risk assessment, all possible relevant information such as accident statistics, location and emergency services, ergonomic studies, research reports, manufacturers' specifications, design criteria and performance figures for all relevant equipment, were obtained and considered.

4.5 Periodic Review

In addition to the periodic review required by Section 11(4) of the MHSA, this standard shall be reviewed and updated after every emergency, altered circumstance, or if significant changes are introduced to procedures, mining layouts, mining methods, plant or equipment and material.


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Table 1: Risk Ratings and Actions


Risk Rating	Rating Parameter	Remedial Action Requirements
Catastrophic	20-25	Immediate Remedial Action – STOP and FIX – continuation of work only allowed after fixed
High	15-16	Immediate Remedial Action – Fix within 48 hours from when hazard is identified
Medium	8-12	Permanent Remedy to be implemented within 1 week
Low	3-6	Requires action when practically possible; continuous monitoring
Tolerable	1-2	No immediate action; continuous monitoring

Table 1: Risk Rating and Actions

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Table 2: Risk Rating Matrix

RISK RATING MATRIX								
SEVERITY				PROBABILITY				
Severity	People	Environment	Financial Loss	5	4	3	2	1
				<u>Probable</u> Likely to occur immediately or soon; has happened more than once per year at the location.	<u>Reasonable Probability</u> Likely to occur eventually; has happened in the organization.	<u>Possible</u> Has happened in the organization or more than once per year in the industry.	<u>Remote</u> Heard of in the industry but rarely happens.	<u>Extremely Remote</u> Never heard of happening in the industry.
5	Imminent Danger resulting in fatalities, Widespread occupational illness	Major environmental impact, and/or total loss of facilities.	Major financial loss resulting in expenses > R1 000 000	25	20	15	10	5
4	Severe injury resulting in a reportable injury and time loss > 14 days and/or serious illness	Serious environmental impact, property and/or equipment damage	Serious Financial loss resulting in expenses of R 500 000 to R 1 000 000	20	16	12	8	4
3	Minor, non-serious injury or illness resulting in time loss <14 days	Minor environmental, property, and/or equipment damage	Moderate Financial loss resulting in expenses of R 100 000 to R 500 000	15	12	9	6	3
2	Negligible, minor injury requiring medical treatment Treat and return	Negligible environmental impact or property damage with no lasting impact & minimal repair cost	Minor Financial loss resulting in expenses of R 10 000 to R 100 000	10	8	6	4	2
1	Minor injury requiring first aid treatment	No environmental impact or damage to property	Financial loss resulting in expenses < R10 000	5	4	3	2	1

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5. ASPECTS ADDRESSED IN FIRE PREVENTION CRITICAL RISK CONTROL.

To manage the risks associated with fires at a mine, this STANDARD sets out a structured Fire Risk Management Program covering the steps and measures envisaged in the guideline. Figure 2 below shows diagrammatically the Fire Risk Management Program covered in this STANDARD.

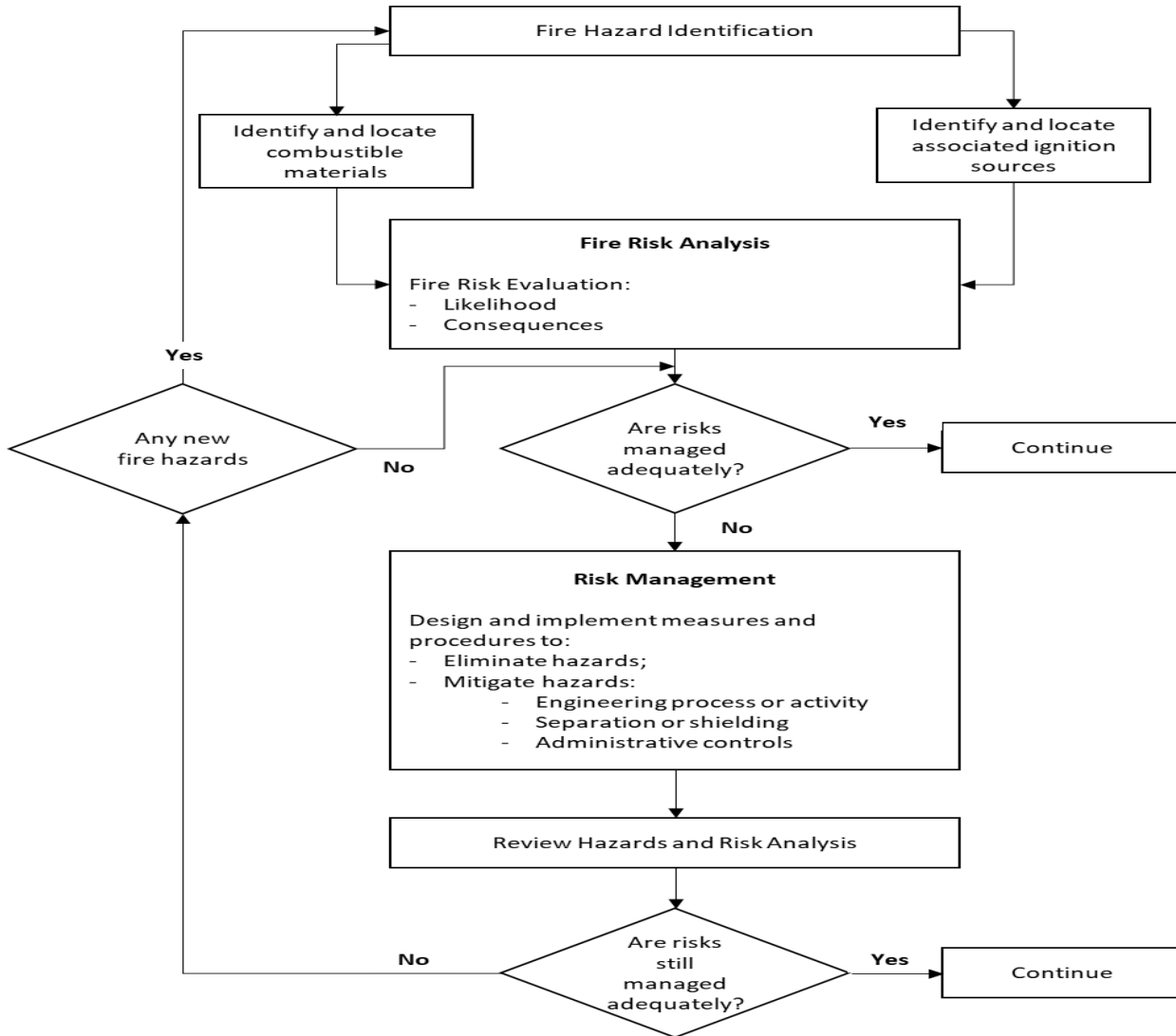



Figure 1: Diagrammatic Representation of Fire Risk Management

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5.1 Fire and Risk Management

This standard sets out the first element of the Fire Risk Management Program, which will identify the Fire Hazards and then the Fire Risks. This should be continuous activities, covering the following:

5.1.1 Identification of Fire Hazards.

Below sets out identified Fire Hazards, classification, and its location as fixed, semi-mobile or mobile at the operation.


Fire will occur if these two sources are present simultaneously in time and space, preventative measures will be put in place to prevent such interactions, and under certain conditions, and physical barriers may be erected to prevent these sources from interacting.

Preventive procedures such as evacuation drills and use of refuge bays will be mitigating actions to deal with fire outbreak. This standard will focus on preventative measures rather than mitigating measures to deal with the outbreak of fires at TNCL mine.

5.1.2 The Nature and development of fire

- **'Fire Triangle'**

(Oxygen, Heat, Fuel plus Chain Reaction) fires start when a flammable material or liquid, in combination with a sufficient quality of an oxidizer such as oxygen gas or oxygen-rich air is exposed to a source of heat or ambient temperature above the flash point for the fuel/oxidizer mix and is able to sustain a rate of rapid oxidation that produces a chain reaction.

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5.1.3 Four Stages of fire

By most standards, there are 4 stages of a fire. These stages are incipient, growth, fully developed, and decay. The following is a brief overview of each stage.

a) Incipient

This first stage begins when heat, oxygen and a fuel source combine and have a chemical reaction resulting in fire. This is also known as “ignition” and is usually represented by a very small fire which often goes out on its own, before the following stages are reached. Recognising a fire at this stage provides the best chance at suppression or escape.

b) Growth

The growth stage is where the structures, fire load and oxygen are used as fuel for the fire. There are numerous factors affecting the growth stage including where the fire started, what combustibles are near it, ceiling height and the potential for “thermal layering”. It is during this shortest of the 4 stages when a deadly “flashover” can occur: potentially trapping, injuring or killing fire-fighters.

c) Fully Developed

When the growth stage has reached its maximum and all combustible materials have been ignited, a fire is considered fully developed. This is the hottest phase of a fire and the most dangerous for anyone trapped within.

d) Decay

Usually, the longest stage of a fire, the decay stage is characterised a significant decrease in oxygen or fuel, putting an end to the fire. Two common dangers during this stage are firstly – the existence of non-flaming combustibles, which can potentially start a new fire if not fully extinguished. Secondly, there is the danger of a back draft when oxygen is reintroduced to a volatile, confined spaces

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Table 3: Fire Risk Hazards Register

Item	Potential Fire Risk Areas of the mine / Plant	Fuel Source	Ignition Source	Fire Risk Scenarios (what/how/when can it happen?)	Current Controls	Risk to health and safety of people, (property, production, environment)
1	Fixed Mechanical Plant	Mono Winch		Friction on ropes		People, Production, and environment
		Conveyor belt	Friction	Friction on bearings	Monitor temperature, Scheduled Maintenance. OEM recommendations	People, Production and environment
		Conveyor belt	Friction	Belt slip causing friction	Slip detector to stop Conveyor belt immediately when there's slip	People, Production and environment
		Conveyor belt	Hot work	Fire	Prevent hot slag from falling into the belt. Have water ready to extinguish.	People, Production and environment
		Conveyor Pulleys	Friction	Friction between belt and pulley	Scheduled Maintenance and Inspection	People, Production and environment
2	Fixed Electrical Plant	Cables	Overheating, Earth fault, Damages	Fire	Overload protection, earth leakage protection. Suspend and ensure visibility of cables	People, Production, and environment
		Mini-Substation	Overheating,	Fire	Temperature Monitor, Overload protection	People, Production and environment
		Switch gears	Short circuit	Fire	Short circuit protection	People, Production and environment
		Collision machine by	Heat	Fire	Illumination, Signs and clear visibility and demarcation	People, Production and environment
			Lightning	Fire	Lightning protection	People, Production and environment
3	Mobile Equipment	Fuel	Hot surface	Fire	Prevent fuel from spilling into hot surface	People, Production and environment
		Oil leaks	Hot Surface	Fire	Prevent oil from leaking into hot surfaces	People, Production and environment



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Item	Potential Fire Risk Areas of the mine / Plant	Fuel Source	Ignition Source	Fire Risk Scenarios (what/how/when can it happen?)	Current Controls	Risk to health and safety of people, (property, production, environment)
		Flammable hoses		Fire	Use fire retardant hoses	People, Production and environment
			Hot surfaces	Fire	Monitor engine operating temperature	People, Production and environment
4	Refuelling bays	Gas accumulation		Fire	Provide good ventilation	People, Production and environment
			Hot work	Fire	Hot work is only performed in dedicated areas	People, Production and environment
		Spillage		Fire	Bund wall and spillage kit to clean	People, Production and environment
			Running engine	Fire	Switch off engine before refuelling	People, Production and environment
			Contrabands	Fire	Contrabands strictly prohibited	People, Production and environment
			Static electricity	Fire	Earthing of equipment	People, Production and environment
5	Battery charging bays		Contrabands	Fire	Contrabands strictly prohibited	People, Production and environment
			Gas accumulation	Fire	Ensure proper ventilation	People, Production and environment
				Fire	Interlock fan with battery chargers	People, Production and environment
6	workshop	Spillages	Hot surfaces	Fire	Cleaning of spillages	People, Production and environment
		Accumulation of gases		Fire	Ensure adequate ventilation	People, Production and environment
			Contraband	Fire	No contrabands in workshops	People, Production and environment



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			Collision	Fire	Traffic management and CWS	People, Production and environment
			Flammable material	Fire	Dedicated storage place	People, Production and environment
			Hot work	Fire	Dedicated hot work area	People, Production and environment
		Poor waste management		Fire	Ensure proper waste management	People, Production and environment
		Refuelling bays				
		Poor storage of chemicals		Fire	Chemicals to be segregated	People, Production and environment
7	Combustible and Flammable liquid stores	Accumulation of gases		Fire	Provide adequate ventilation	People, Production and environment
		Contrabands	Contrabands	Fire	No contraband allowed	People, Production and environment
			Hot work	Fire	No hot work allowed	People, Production and environment
8	Explosive storage	Contrabands	Contrabands	Fire	No contraband allowed	People, Production and environment
		Hot work		Fire	Hot work not allowed	People, Production and environment
		Poor housekeeping		Fire	Ensure proper housekeeping	People, Production and environment
		Poor handling and transporting of explosives		Fire	Handle, transport explosives as per the procedure and SAPS standard	People, Production and environment



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Item	Potential Fire Risk Areas of the mine / Plant	Fuel Source	Ignition Source	Fire Risk Scenarios (what/how/when can it happen?)	Current Controls	Risk to health and safety of people, (property, production, environment)
			Running engine while loading	Fire	Engine to be shut off while loading explosives	People, Production and environment
			Flammable gases	Fire	Storage of flammable gases is not allowed	People, Production and environment
9	Accumulation of flammable gases		Hot surfaces	Fire	Ensure proper ventilation is maintained	People, Production and environment
		Contrabands		Fire	Contrabands prohibited	People, Production and environment
		Poor segregation of chemicals		Fire	Segregate chemicals	People, Production and environment
10	Hot work (Welding and cutting)		Naked flames	Fire	No hot work near flammable materials, Test for gases	People, Production and environment
		Conveyor belt		Fire	Have running water ready to extinguish any slag on the conveyor	People, Production and environment
			Accumulation of gases	Fire	Only do hot work in the dedicated area, ensure hot work permit is obtained outside the dedicated area	People, Production and environment
11	Abandoned panels or Workplaces	Accumulation of gases		Fire	Use GDI to test for gases	People, Production and environment
12	Crushers		Bearing Friction	Fire	Ensure proper periodic maintenance	People, Production and environment
		Spillages, overloading		Fire	Good housekeeping to be maintained.	People, Production and environment
				Fire		People, Production and environment
13	Pump Stations		Cavitation	Fire	Ensure proper suction is maintained. Prevent pump from running dry	People, Production and environment



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Item	Potential Fire Risk Areas of the mine / Plant	Fuel Source	Ignition Source	Fire Risk Scenarios (what/how/when can it happen?)	Current Controls	Risk to health and safety of people, (property, production, environment)
			Motor single phasing	Fire	Overload protection	People, Production and environment
		Poor earthing		Fire	Ensure good earthing	People, Production and environment
			Slip on V belts	Fire	Conduct inspection and maintenance regularly	People, Production and environment
14	Veld fires	Dry grass	Lightning	Fire	Fire breaks	People, Production and environment
			Arson	Fire		People, Production and environment

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Annexure 1 Generic notes on fires provides more information on the stages of fire, covering the nature and development thereof.

6. CLASSES OF FIRE (FUEL SOURCES)

a) **Class A:** Materials (Ordinary Combustibles)

These are solid materials, usually of organic nature, in which combustion normally result in the formation of glowing embers. These are combustibles such as wood, paper, fabric, plastic, and most cases of solid material.

b) **Class B:** Materials (Flammable liquids and gasses)

These are non-solid fuels consisting of flammable or combustible liquids or gasses such as petrol or propane gas.

Flammable liquids are classified in terms of the latest version of SANS 10089-1 as:
Fuel sources.

Class 0: Liquified petroleum gasses (LPG).

Class 1 A/B: Liquids with a closed-cup flash point below 23°C.

Class 1C : Liquids with a closed-cup flash point between 23°C and 38°C.

Class 2: Liquids with a closed-cup flash point between 38°C and 60,5°C.

Class 3A : Liquids with a closed-cup flash point between 60,6°C and 93°C; and


Class 3B : Liquids with a closed-cup flash point of 93°C or above.

c) **Class C:** Energises electrical equipment.

Electrical fires involve potentially energised electrical equipment. This sort of fire may be caused by short circuiting or overloaded networks.

d) **Class D:** Combustible metals.

Combustible metals mostly encountered are magnesium, potassium, titanium, and zirconium. Except for the metals that burn in contact with air or water (for example potassium and sodium), combustible metals on their own do does not represent unusual fire risks because

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they have the ability to conduct heat away from hot spots efficiently. However, when combustion is induced, the fire is self-sustaining: rapid combustion (oxidation) of magnesium induced by an external source may result in a fiercely exothermic process.

e) **Class E:** Cooking oils and fats (kitchen fires)

These include unsaturated cooking oils in well-insulated cooking appliances located in commercial kitchens. Though such fires are technically a sub-class of the flammable liquid/gas category, the special characteristics of these types of fires, namely the lower flash point, are considered important enough to re-classify these separately. Water mist can be used to extinguish such fires.

7. FIRE HAZARDS: IGNITION SOURCES


a) **Heat energy.**

The presence of heat energy is often characterised by high temperature surfaces (e.g. exhaust systems of internal combustion engines, pumps, turbochargers, electric motors, gearboxes, heat exchangers, bearings, rubbing surfaces such as brakes, cigarette butts, naked flames from use of welding equipment and matches or cigarette lighters).

b) **Electrical energy**

Electrical infrastructure and equipment such as distribution boxes, cable shafts, circuit breakers, cables, wires, and transformers can become a source of ignition through sparking or overheating. Fire may be caused by short circuits, earthling faults, faulty distribution systems or electrostatic discharges. Electrical equipment operating where methane, sulphide dust or other fire hazards may be present should be closely monitored. As with mechanical equipment, electrical fires may be the consequence of equipment misuse, removal of safety protection, lack of maintenance, or tampering.

Electrical energy — electrical discharge in motors, retarders and transformers, short-circuit arcs, earthling faults, static electricity discharge, mobile equipment contact with high-voltage (HV) power cables.

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c) **Mechanical energy.**

Friction (conveyor belts drives, winch ropes) or grinding.

d) **Chemical energy**

Self-heating, auto-ignition, exothermic reactions, spontaneous combustion of coal and induced pyrolysis of vehicle tyres. (lightning)

- **Conveyors**


Conveyors present a significant fire risk because they can carry fire along their belt length very quickly.

Conveyor fires are usually started by the friction caused when the belt becomes Staked at any point and the drive rollers continue to rotate, resulting in high temperatures developing at the drive end. A seized belt roller or return roller may also become red hot from the friction of the belt running over it.

8. FIRE HAZARDS: IDENTIFICATION PROCESS

Examples of fire hazards at Tembo Nickel Mine. (not limited to):

- Fixed mechanical equipment or plant using mechanical friction such as mono-winch and associated winch rope systems, conveyor belt drives and pulleys.
- Fixed electrical equipment: electrical short circuits or over heating of oil-filled transformers or switchgear; (particularly where these are in main intake airway systems).
- Mobile equipment: fuel or oil leaks on hot exhaust manifolds or the surface of a turbocharger.
- Re-fuelling bays and battery charging bays.
- Underground workshop areas (storage of fuels, grease, oils, paint, tyres, hoses) in the presence of mobile equipment and where extensive hot work is performed.
- Combustible and flammable liquid stores.
- Explosives storage areas.
- Locations where combustible or flammable dust or gases can accumulate.
- Flame cutting and welding operations, particularly near combustible material.

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- Abandoned panels or workplaces: spontaneous ignition of support timber.
- Conveyor belt installations
 - Surface
- Major transformer stations and electrical switchgear installations.
- Storage installations for fuel or other flammable chemicals.
- Overland conveyor belts.
- Spoil piles (induced fires or self-ignition).
- Explosive magazines or temporary transfer storage facilities.
- Waste storage or disposal areas.
- Natural or agricultural areas near, surface infrastructure or declines (plant material fires).
- Conveyor belt installations

(i) Baseline and Issue-based fire hazard surveys

A baseline fire hazard survey will be done and summarised in the fire hazard register that will include the following:


- a. Date of the survey.
- b. Name of the person responsible for the respective assessment.
- c. A list of operational procedures that were affected as a result of the assessment.
- d. Details of where the official risk assessment documentation is kept at the mine.

The survey will be completed as soon as any type of mining operation is undertaken or whenever major changes to the operation is undertaken e.g. Management of change (construction, mining method changes, ramp-up etc.)

The risk survey will be used as a basis for the assessment and control of fire risks.

(ii) Continuous fire hazard identification:

Where any equipment systems or processes are required to change, the TNCL Mine Management of Change procedure will be utilised to identify any changes from the original fire hazard register. The Management of Change procedure will include guidance to ensure that new or changed fire hazards are addressed according to all requirements of this Standard.

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In addition, the fire hazard register will be reviewed on an annual basis to ensure that it stays current. These reviews will include, but won't be limited to fire risks that were identified by:

- a. Employees utilising the incident reporting system as well as all forms of pre-work risk assessment (e.g. Safe declaration, pre-use checklists etc.).
- b. Management, supervisors, and safety personnel conducting formal and informal inspections of workplaces.
- c. Maintenance personnel during planned maintenance inspections on equipment as well as during breakdowns.

9. ASSESSMENT OF FIRE RISK

9.1 Fire Risk Assessment Method

All fire hazards are analysed to ensure that the specific hazard is understood in terms of its contribution of the overall fire risk. Fire risk assessments include the following:


- a. Identified fuel and potential ignition sources are analysed in the hazard inventory in terms of magnitude of the hazard as well as hazard release mechanisms for the hazard.
- b. The fire risk is evaluated in line with the Sefateng Risk Matrix, based on the assessed consequence and likelihood, to arrive at a risk ranking for each fire hazard. The Method used is WRAC (Workplace Risk Assessment and Controls)
- c. Specialists from all relevant areas, including occupational hygiene, emergency preparedness and specialist service providers are included in teams assembled to conduct fire risk assessments.

Where appropriate, similar fire hazards or classes of fire hazards will be analysed in logical groupings.

9.2 Fire Risk Assessment Tools

The Operational Risk Management System considers the impact of the risk on health and safety of employees, contractors and visitors as well as impacts on the environment that may result from fire incidents. The risk assessment tools focus on:

- a. The actual risk as understood at the time of assessment.
- b. Interventions used to effectively reduce the risk.
- c. The effects of said intervention.

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- d. The impact of residual risk after the application.
- e. Further measures that might be applied
- f. Monitoring criteria to determine effectiveness of application.

The possible impact on neighbouring communities, impacts of legal and regulatory non-compliance and possible financial and reputational impact on the Company are also formally considered.

9.3 Risk Analysis

The Sefateng Operational Risk Management System was used to analyse risk and establish a hazard inventory in baseline and issue-based risk assessment. The hazard inventory required hazard descriptions, magnitude, and hazard release mechanisms, resulting in a clear understanding of every hazard.

9.4 Risk Assessment Output


The risk assessment output addressed the following:

- a. Locations throughout the mine where fuel and ignition sources exist:
- b. Types and extent of fire events considered:
- c. Consequence and likelihood of each fire event:
- d. The resulting fire risk (e.g. based on a consequence and likelihood risk matrix):
- e. Controls and associated monitoring criteria currently in use to minimise the risk:
- f. Any additional actions aimed at mitigating or reducing the impact of the outcome.

9.5 Fire Prevention Controls

In this section of the standard, the application of adequate controls for fire prevention at mines is described by considering the systems, processes and equipment employed at the mine. A control is an action aimed primarily at preventing the occurrence of a fire incident or an intervention intended to limit the impact of any incipient fire. These can take the form of a process or equipment re-design, implementation of different material selection criteria or of adequate operational standards.

Controls shall be assigned to each fire hazard and corresponding risks identified and defined in the fire risk management section. The number and degree of coverage of controls shall be commensurate with the level of anticipated risk.

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All fire prevention controls should be listed in the standard and must be aligned with the findings of the various fire risk assessments. To this end, the standard should include a register listing all fire prevention controls (in place or planned) including risk-based monitoring criteria together with the reference risk assessment document to which they are linked. Critical controls are actions or interventions whose integrity will ensure that the hazard will not cause harm and should be recognised as such in the controls register.

a) Design, construction, and operation


Vehicles:

- a. Adequate number of fire extinguishers and their appropriate class will be provided.
- b. On board fire extinguishers is provided for all underground vehicle
- c. All power lines where vehicles pass under, the permitted height will be marked.
- d. Hydraulic hoses:
 - i. Only fire-retardant fire hoses that meet the requirements of as per standard
 - ii. All hoses will be securely clamped away from hot surfaces.
 - iii. It will be located in such a way that damage is minimized.
 - iv. It will be provided with bulkhead fittings where it passes through bulkheads.
- e. Flammable fluid containers will be located such that any overflow will not contact hot surfaces.

Annexure 4 General Design Requirements Mobile Equipment and **Annexure 5** General Design Requirements for Fuel Storage Areas, Fuel Transfer Equipment and Refueling Bays provide principles against which design, construction and operational parameters may be assessed in relation to fire hazards for inclusion in the standard.

Engine systems:

- a. In case of emergency the operator will safely switch the engine off.
- b. Engine control system will automatically shut off fuel supply whenever a fault necessitates it.
- c. Whenever working pressures are exceeded the engine will shut down.
- d. All bulkheads will be fireproof.

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Vehicle Electrical systems:

- a. Fuses are used to protect against short circuit and over current.
- b. Electrical cables will be at a safe distance from fuel lines.
- c. Electrical sparks will be minimised by installation of fuses.
- d. All wiring is to be done as per OEM specifications.
- e. All jump-starting systems will be used as per OEM specifications.
- f. All circuits will be protected, except starter motors against short circuit and over current.


Vehicle fuel and hydraulic systems:

- a. All exposed lubrication system will be supplied using steel lines.
- b. Flexible hoses will be able to limit the spread of fire.
- c. Vents and Overflows will be directed away from hot surfaces.
- d. Hoses, oil, fuel and hydraulic lines, and fittings will be installed as per OEM specifications.
- e. Fuel, Oil lines, and hoses will be separate from electrical cables where necessary.
- f. Fuel, Oil lines, and hoses will be protected against moving parts.
- g. The flash points of all liquids will be used by mobile equipment will be below ambient temperature experienced.
- h. Burst hoses will not spray fuel against hot surfaces.
- i. **Hoses to be:**
 - Securely clamped away from hot surfaces
 - Located so that impact damage is minimized; and
 - Provided with bulkhead fittings where they pass through bulkheads.

Tyres and power transmission:

- a. Tyres should be selected to suit their intended application in accordance with the OEM design and specifications.
- b. N/A on Sefateng Mine (Flame retardant “V” belts on mobile equipment will be used.)

Other Mobile equipment requirements:

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- a. Engine oil pressure will be monitored and stops engine if pre-determined values are exceeded.
- b. Turbocharger lubrication lines will be made of steel and where flexible hoses are used it will be fire retardant located away from hot surfaces.
- c. Vehicles transporting combustible liquids and Gases as per compliance on tanker standard.
- d. Explosives will be transported in separate enclosed compartments.

Fuel storage and refuelling bays.


Portable fuel containers are only used for transporting fuel when they are secured in holders protecting them from damage when being carried on vehicles.

Ensure that there's appropriate signage at the entrance to fuel storage areas advising:

- a. Flammable materials are stored inside.
- b. No unauthorised personnel.
- c. No flames or naked lights.
- d. No hot work.
- e. Engines should be shut off before refuelling.
- f. Emergency procedures in the event of fire.
- g. Permanent fuel storage locations have a floor that is impervious to fuel, and it has a bund wall.
- h. Temporary storage will be used after completion of a risk assessment that evaluates the potential risk, and suitable controls to minimise the impact of, fuel spills.

b) Mine infrastructure

The standard identifies fire hazards and record in the fire hazard registers all infrastructure and installations that could pose a significant fire risk such as, but not limited to

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a. Fuel storage and associated transfer equipment.


- The volume of fuel stored underground must not exceed three day's supply.
- Fuel must be stored in stainless steel containers.
- Containers must be in through ventilation.
- No open flame signs to be displayed.
- Fire suppression system to be installed.
- Bund wall big enough to hold 110% fuel.
- Fuel storage areas to be equipped with fire detection monitor.
- Firefighting equipment to be installed on intake side of fuel storage.

b. Refuelling bays

- Installed in through ventilation.
- Ventilated directly to the return.
- No contraband and no open flame signs to be displayed.
- No torch cutting or welding within a radius of 30m from refuelling bays.
- Spilled fuel to be washed away and collected from sump.
- Refuelling bays must have a proper cement floor.
- All vehicles to be switched off during refuelling.
- Refuelling bays to be equipped with an automatic fire suppression system.
- Refuelling bays to be equipped with a fire detection system.

c. Main substations and switchgear installations

- To be installed in through ventilation.
- Ventilated directly to return airway if possible.
- Oil filled sub stations to be equipped with a bund wall that can handle 110% of oil.
- Ensure that the necessary symbolic signs are displayed.
- Firefighting equipment to be placed at the intake side.
- To be equipped with a fire suppression system.
- To be equipped with a fire detection monitor.

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d. **Underground hoisting stations**

- N/A for TNCL

e. **Workshops**

- No liquid combustible materials to be stored closer than 30m from working area.
- Must be installed in through ventilation.
- Must be ventilated directly to the return airway.
- Adequate firefighting equipment available at intake side of workshop
- No combustible materials to be stored within a radius of 30m from working areas.

f. **Densely timbered areas in intake airways**

- To be sprayed with fire retardant chemical.
- Accumulation of combustible materials to be sprayed with fire retardant chemicals to minimise the risk of the start and spread of fires.

g. **Diesel fuel lines in main shafts and declines – where these are used for transport.**


- N/A

h. **Any fire hazardous areas as classifiable by SANS 10108: Fire hazardous area classification**

- Only workshops, refuelling bays and fuel storage areas, discussed under each individual heading.

i. **High density surface storage area, e.g. fire hazardous material and combustible liquid storage areas, timber yards, fuel storage tanks, liquid oxygen tanks, ammonia refrigeration plants, etc.; and**


- All surface areas to be covered by a fire hydrant and hose.
- No open flame symbolic signs to be displayed.
- Storage areas to be no closer than 50m from main intake airways and shafts.
- Storage areas to be on the downside of the prevailing wind direction when close to main intake areas and shafts.

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- Fire hose reels to be able to cover whole storage area.
 - Fire hose reels to be supplied with continuous water supply.
- j. **Waste disposal containers.**
- To be emptied as soon as containers are full.
 - No open flames within 30m from containers
- k. **Worked out areas.**
- To be clearly demarcated
 - All electric cables to be isolated when area is abandoned.
 - All electrical equipment and cables to be removed from work out area,
 - All temporary stopped ends all electrical equipment to be isolated, locked out and barricaded until removed.
 - All stopped ends to be recorded in the stopped end register.
- l. **Combustible Materials**
- All combustible materials to be bought of fire-resistant material.
 - Materials not being able to source with fire resistant material must be treated with a fire-retardant chemical before proceeding underground.

To minimise fire risk at critical installations and infrastructures, the following requirements should be considered at the design stage:

- a. The installation of infrastructure that could pose a heightened high fire risk should only be undertaken following a formal assessment and consideration of the controls necessary to minimise risk; and
- b. Wherever possible, such high-risk infrastructures should be in the return airways or near these, to facilitate exhausting of smoke and gases directly to return in the event of a fire and/or be equipped with suitably designed fire doors that would shut-off in the event of a fire thereby limiting or reducing smoke contamination of fresh air streams.

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c) Fixed Plants

The Standard address the following list of fixed plant components that should be assessed as part of fire hazard identification audits.

a. Air compressor

- Compressors are located on the surface.
- Compressors are designed in such a way that in the event of fire the amount of smoke entering the main intake is eliminated.

Sufficient electrical bonding and earthing of compressed air equipment, hoses, and pipes that is likely while in operation to develop static electrical charges that are capable of causing an electric shock to a person or a spark.

b. Major Electrical installations


Underground fixed electrical and associated equipment include substations, switch-rooms and main distribution boards.

- Thermistors with automatic temperature stop functions.
- Over current, earth-leakage and short circuit protection.

Where possible, transformers should use non-flammable oils and be designed to contain oil leaks. However, where flammable oil is used, fixed electrical equipment should:

- be provided with automatic fire suppression systems
- be located so that the air flowing over them passes direct to return
- have bunds capable of containing the total oil volume with a 10 per cent excess to capture any oil spillage.

The fixed electrical installation should be designed to eliminate the need for maintenance workers to work on live apparatus and should be located so they cannot be damaged by impact from Mobile equipment collision or blasting. Attached reflectors will make installations clearly visible to operators.

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When major electrical installations become redundant all electrical equipment and cables must be removed.

c. Crushers

Regular maintenance is conducted as per OME guidelines to prevent failure of critical components which might cause fire.

d. Mineral processing plant


Mineral Process plants – conveyor belts, feeders, flammable materials, hot work, and wash plant and structures fire hazards may pose different risks depending on the level above ground, (hot work, plant/machinery failure, ore spillage/accumulations, and flammable materials).

e. Conveyor belt installations

Conveyor belt releases high volumes of smoke, carbon monoxide and other toxic fumes that can quickly pollute the general body of air. As belt fires spread along a belt in the direction of the airflow, they are difficult to extinguish because the smoke and toxic fumes prevent fire-fighting the advancing front along the belt. Fire resistant conveyor belts will not ignite by frictional heat when a rotating pulley rubs against a stalled conveyor, and flame will not spread along the belt if part of it is exposed to flame.

At TNCL Mine Prevention controls include the installation of belt-alignment switches and slip detector. To detect when the belt is running out of line and stop the Conveyor belt when slip occur in the pulleys.

- Smoke sensors will be installed in high fire risk areas on underground conveyor installation and glory holes in the plant. (Implementation plan)
- Implementation of preventive maintenance programmes.
Comprehensive maintenance and inspection plans, as well as emergency Plans.

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- a. Spillage and accumulation of materials is controlled at transfer.
- b. Inspection and maintenance at designated sections.
- c. Conveyor belts are properly tensioned to avoid slipping.
- d. Conveyors are fitted with:
 - (i) Slip and tear detector will be installed on Conveyor belt installation.
 - (ii) Smoke detectors and CO monitors on drives and at transfer points.
 - (iii) Fire suppression systems is fitted to the conveyor belt installation, Fire hoses and fire extinguishers are also available.


- f. **Hoist rooms (Mono-winch)**
N/A

- g. **Pump stations.**
 - Motor is protected against overcurrent and earth fault.
 - Cables are protected against overheating.
 - Pumps are protected against running dry.
 - Positive suction.

- h. **Raise borers N/A**
- i. **Shaft sinking N/A**
- j. **Material handling and equipment**
- k. **Fire hazard material and combustible liquid store.**

Annexure 3: Mine Infrastructure and Fixed Plant provides examples of preventative controls that should be considered for underground, and surface fixed plant installations located within fire and explosion hazardous areas.

All fixed electrical and associated equipment, including substations, switch rooms, motor control centres (MCCs), transformers, distribution boards, overhead power lines and electrical reticulation systems, shall be designed, installed, operated, inspected and maintained in accordance with applicable Tanzanian legislation, manufacturer specifications, and internationally recognized standards, including but not limited to:

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The Mining Act of Tanzania and its applicable Regulations.

- The Occupational Safety and Health Act (OSHA), 2003 and associated regulations.
- The Electricity Act and regulations issued by the Energy and Water Utilities Regulatory Authority (EWURA).
- Tanzania Electric Supply Company (TANESCO) Grid Code and Technical Standards.
- IEC 60079 Series – Explosive Atmospheres.
- IEC 60076 Series – Power Transformers.
- IEC 61936-1 – Power Installations Exceeding 1 kV AC.
- IEC 60364 Series – Low-Voltage Electrical Installations.
- ISO 80079 Series – Equipment and Protective Systems for Explosive Atmospheres.
- NFPA Standards where applicable for fire protection and electrical safety.
- Any site-specific engineering standards approved by the mine owner.


Electrical equipment installed in hazardous areas shall be appropriately certified for the designated hazardous area classification and protected against potential ignition sources. Inspection, testing, maintenance and verification activities shall be conducted by competent and authorized personnel in accordance with the applicable regulatory and technical requirements.

- a. Be designed constructed and installed in accordance with the manufacturer’s standard.
- b. Be equipped with at least over-current, earth leakage and short circuit protection.
- c. Be designed and constructed so that oil leaking from transformers and switchgear installations is contained; and
- d. Consider the use of “dry”, “inert gas” or emulsified (low flammability) coolant options for transformer and switchgear equipment.

Fire prevention measures and protection equipment considered for these installations shall be designed to address adequately and reasonably the level of fire risk.

Where flammable oil is used, fixed electrical equipment should:

- a. Be provided with **fire suppression systems**.
- b. Be located so that the air current that flows over them passes direct to return; and

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- c. Have aggregate bund walls capable of containing the total oil volume with a plus 10% excess to capture any oil spillage.

The Standard includes details of any fire detection systems installed following the respective fire risk assessment action plan as well as of any fire-fighting equipment provided as a further protective measure. This specialised equipment should be designed, installed and maintained in association with competent fire engineering experts.


d) Workshops

The standard references the design and operation of workshops both on surface and underground. The following aspects should be included in workshop standards and operating procedures:

- a. A workshop contains a minimum storage of combustible liquids (oils, lubricants, fuel, etc.). Storage quantities will not exceed consumption for one week's work.
- b. Any combustible liquids be stored in segregated locations and banded.
- c. Appropriate signage at entrances to workshops indicate:
- Type and volume of combustible liquids stored.
 - No smoking or naked lights near flammables
 - Hot work in designated areas only
 - Housekeeping requirements; and
 - Emergency procedure in case of fire.
- d. The maximum mass of combustible materials stored or in use in a workshop in different subdivisions shall not exceed one week consumption (e.g. fuel, lubricants, grease, rubber or polyurethane filled tyres, paints, welding gas cylinders, etc.). This information will be used to determine the appropriate type and quantity of fire-fighting equipment as well as the location of any fire detection sensors.
- e. The design of the ventilation system serving workshops must follow a risk-based approach that caters for:

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- Position of machinery, equipment, temporarily stored material (consumables) vehicles being serviced at any one time (e.g. diesel emissions, hydrogen liberated during battery charging, etc.) and the workshop volume taken-up by these under normal and exceptional circumstances. These will all affect air-flow patterns in the workshop, response of any smoke sensing equipment and effectiveness of any fixed fire suppression equipment.
 - Positioning of the workshop in relation to intake and return airways. This is important to determine the strategy to be adopted in the event of a fire and the type of fire detection and fire-fighting tactic; and
 - Contingency arrangements may be required in the event of power failures.
- f. All Hot work (Welding, grinding, cutting, or heating or burning using oxy-acetylene or electric welding) is performed in a well-ventilated designated place to dilute any smoke or fumes generated by such work.
- g. Where hot work is performed outside the dedicated area in the mine, hot work permit will be required.
- h. Chemicals in stores that can generate heat or release fumes will be appropriately separated from workshops working areas.
- i. Sealed waste oil disposal system and suitable containers for the disposal of other flammable waste is used to minimise spillage.
- j. Space heaters are not to be used in workshops unless they have a surface temperature less than 300°C and are kept clear of rags, paper and other flammable material.
- k. Welding gases such as acetylene and oxygen will be stored and used in accordance with OEM requirements.
- l. Workshops are provided with adequate spillage containment facilities (e.g. water hose, absorbent material) to contain or clean-up any fuel spills quickly and effectively.

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- m. Any waste (e.g. soiled absorbent material) is placed immediately in clearly marked receptacles and be kept well away from any potential ignition source these receptacles should be emptied regularly.
- n. Risk based fire extinguishers and fire-fighting equipment will be installed, inspected and maintained as per OME specifications.
- o. Dedicated parking area is provided as per traffic management plan away from flammable materials.


e) Mobile Equipment

The standard addresses the risk posed by the operation of self-propelled mobile equipment at a mine or in a confined environment as determined by several factors such as:

- The mass of flammable material on the vehicle.
- The routing (mobility) of the vehicles - particularly in main intake airways - as a vehicle fire is likely to contaminate the air downstream of the event.
- The location of refueling bays or places where (temporary) maintenance is done.
- The air quantity flowing past a potential fire site and sites through which is coursed downstream.

The general design of vehicles conforms to minimum OSHA Compliance: Compression (ignitions engine system and machines powered by such engine system, for use in mines with explosive gas) and plants as applicable or manufacturer’s specification. The routing of electrical (power) cables, fuel and hydraulic lines, particularly in engine bays, near brakes and pinch-points will be such that incidental damage and contact with hot surfaces is avoided. Pipes and hoses will be manufactured from high quality; durable materials and the piping layout will consider abrasive action and allow for adequate mobility.

Annexure 4: General Design Requirements Mobile Equipment provides series technical solutions and risks posed by the operation of self-propelled mobile equipment.

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Annexure 6: Safe Use, Transport and Handling of Explosives provide examples of preventative controls that should be considered underground and on surface for the transport of explosives (Referencing to the explosive procedure in terms of Mining regulations)

10. MANAGING FIRE POTENTIALS

The standard indicates measures to address the storage and use of such substances or materials that have a flash point below 60°C, including compressed gases such as acetylene and propane. The use and presence of flammable substances at a mine is inevitable and therefore the risk posed by these must be managed adequately.

List of global harmonised classification and labelling of chemicals will be consulted to determine the type of any precautionary measures that require implementation.


a. Good Housekeeping

To prevent fires, good housekeeping is of essential value, especially in areas of high risk such as Hazardous identified areas. Stacking and accumulation of timber or combustible materials should be prevented. Stacking of combustible materials must be done in areas especially dedicated for that purpose. These areas must be equipped with an adequate water supply and hose to cover the whole area.

Workshops and refuelling bays should be free from any combustible materials and no stacking or accumulation of any combustible materials or liquids must be stored or kept within a radius of 30m from such areas.

These areas must have a proper casted floor capable to be washed to ensure that there are no accumulation of oil, grease or fuel on the footwall. It must be designed in such a way that spillages can be washed and removed from the footwall (cement floor) to prevent combustible materials from accumulating in unwanted areas. Each of these areas must be equipped with a sump to catch any spillages that may occur.

Workshops should be equipped with adequate waste disposable drums to isolate different combustible materials from each other. Flammable liquid and solids should be thrown in

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separate waste disposal units. These units should be cleaned on a regular basis to prevent overflow and accumulation of combustible materials.

All electrical equipment and open flame equipment must be stored as per OEM specifications. All the necessary signs as well as good housekeeping signs are displayed at all entrances to workshops and refuelling bays. Combustible materials stored in the workshops must be locked away at the end of the shift.


Spillages should be cleaned daily to prevent accumulation of ore on the belt from starting a friction fire. No spillage to be left on the frame or below the conveyor belt. Main pulley's and return pulley's to be kept clean all the time to prevent friction on the conveyor belt.

All chemicals used at repairing conveyor belts must be removed to surface after repairs are done. No grease or oils to be stored near conveyor belts to prevent possible ignition of fires.

11. GENERAL REQUIREMENTS

The standard set out measures to minimise fire risk associated with the storage or use of flammable substances at the design or selection stage. The following is considered:

- a. Wherever possible and reasonable, flame-retardant materials should be used in preference to flammable materials.
- b. All combustible materials will be stored in dedicated, clearly marked storage areas.
- c. The use and location of flammable substance storage areas should only be undertaken following a formal assessment and consideration of the controls necessary to minimise risk.
- d. Wherever possible and reasonable, flammable substance storage areas should be ventilated into the return airways or have suitable fire doors installed to limit smoke ingress into working areas and intake airways. Flammable substance storage equipment should be constructed of non-flammable materials.
- e. 'No Smoking' and 'No Naked Flame' signs are displayed at all flammable materials storage locations.
- f. Flammable materials are not stored on or near heat or ignition sources.


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- g. The routing of electrical cable clusters, particularly high-tension lines, should not be allowed within proximity from flammable materials. Each application shall be considered on merits dictated by risk considerations, good practice and the use, where necessary, of adequate protective (shielding or separating) measures.
- h. Electrical switchboards will not be placed in flammable material stores.
- i. Wherever possible and reasonable, light fittings will be mounted clear of flammable materials.
- j. All electrical equipment will meet relevant electrical standards for design and installation and will be used as intended by the manufacturer.
- k. Where necessary and as indicated by an assessment of the risk, smoke alarms and earth leakage protection will be installed on electrical equipment that is left to operate unattended.
- l. The quantity of flammable materials stored in any location, should be kept to a minimum as per mine risk assessment.
- m. Flammable material storage equipment should be located away from high traffic or collision-prone areas or be otherwise protected against vehicle collisions.
- n. Wherever possible and reasonable, hot work should not be done in or near flammable materials, in the presence of flammable gases or other such fluids. A permit system for hot work (inclusive of adequate preventative and protective measures) should be in place for any such work outside workshops; and
- o. Wherever possible and reasonable, vehicle access to combustible stores should only be for the purpose of loading and unloading. Vehicles should not be parked in tyre stores.

11.1 Combustible Substances

The standard address measures for the storage and use of combustible substances or materials at mines that generally have a flash point below 60°C. This includes Class 3 flammable liquids.

Foams and resins may be particularly volatile in their component form (i.e. prior to mixing). Where foams are used, it must comply with the governing laws.

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a. Flammable solids


The standard addresses the following requirements related to the use and storage of flammable solid materials:

- i. Where the large-scale use of timber support is necessary, all densely timbered areas, particularly in intake airways and storage areas must be covered with fire retardant chemicals or coating. All underground timber bays must be equipped with an adequate water supply to cover whole storage area.
- ii. The standard outlines any special measures for the prevention of fires in waste storage facilities.
 - Adequate ventilation measures for some waste storage facilities
 - Displaying 'No Smoking' signs in the waste storage facilities and near refuse containers
 - The regular removal of waste materials from refuse containers and waste storage facilities at adequate intervals to prevent the accumulation or overflow of waste materials.
 - Only dedicated cassette is used to transport explosives.

b. Flammable liquids

The standard reflects the following requirements related to the use and storage of flammable liquids:

- i. All vessels containing flammable liquids be provided with clear and easily understood labels and respective MSDSs.
- ii. Only purpose-built containers, designed to prevent spillage, should be used to transport flammable liquids. Diesel fuel should only be transported in purpose-designed bowers or jerry-cans, adequately secured to the vehicle's loading tub.
- iii. Where large quantities of flammable fuels are stored, e.g. diesel fuel storage tanks, oil cooled transformers, etc., and were justified by risk-based considerations, storage vessels will be enclosed in a containment area (bund wall) where any spillage following the rupture of the containment vessel. The

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containment area should be large enough to accommodate 110% of the maximum flammable liquid volume in storage at any time. In addition, if this area should be filled with inert material such as gravel consideration must be taken into the volume of flammable liquid in the storage vessel. If any drainage system is used it must be fitted with a device that is normally closed; and

- iv. The vehicles used for the transport of flammable liquids will be appropriately designed for the task.

Annexure 5: General design requirements fuel storage areas, fuel transfer equipment and refueling bays below include reference to a number of items relating to fuel storage areas, fuel transfer equipment and refueling bays for consideration in structuring standards supporting the management of **fire risks** associated with these.


Annexure 6: Safe use, transport and handling of explosives below provide suggestions that might be included in procedures for the safe transport handling and use of explosives. These are provided for reference and inclusion in operating procedures.

- **Flammable gases**

The management of risks associated with the natural occurrence of flammable gases in underground operations, i.e. resulting from mining operations, is not included in this standard. Reference should be made, however, to the respective standard for the prevention of flammable gas explosions. This standard is to address the use of industrially manufactured flammable gases that may be used in various processes at a mine, mainly welding.

The standard reflects the following requirements related to the use and storage of flammable gases used in “hot work”:

- i. Flammable gas cylinders are stored in a well-ventilated area.
- ii. Flammable gas cylinders are transported and stored in accordance with the relevant manufacturer’s specification.


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- iii. Gas cylinders are secured so that they cannot fall over. Cylinders containing acetylene will be stored in an upright position.
- iv. When transporting cylinders, they will not protrude over the vehicle's loading bed extremities.
- v. Flash-back arresters is installed on all oxy-acetylene equipment.
- vi. The contents of flammable gas cylinders are not decanted; and
- vii. Oxy-acetylene equipment will only be used in accordance with accepted operational standards and only in designated "hot work areas" or when approved using a "hot work permit".

12. OPERATING AND MAINTAINANCE PROCEDURE

The Standard reflects the following:

- a. Operating procedures will be developed from the action plans drawn from the various fire risk assessments.
- b. A maintenance system is in place that ensures that all equipment, both mobile and fixed plant, is maintained properly and according to the manufacturers' recommendations and that any defects are recorded and promptly repaired.
- c. Oversight procedures are in place to ensure that:
 - Regular maintenance of equipment for the prevention of fires, used for fire detection and firefighting is essential in the implementation of the various protection measures.
 - All repair and maintenance activities for machinery, systems and equipment associated with fire risks and employed for fire prevention and protective measures is carried out at specified intervals, by suitably qualified individuals and in accordance with original equipment manufacturer specification.
 - Repair and maintenance activities must restore equipment to the intended design and operational functionality; and
 - Employee's training programmes for fire prevention procedures and awareness will be aligned with requirements and findings of the various fire risk assessments to ensure adequate levels of proficiency and effectiveness and acceptable workmanship.

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Annexure 7: Generic operational and maintenance procedures below provide suggestions that might be included in procedures for generic operational and maintenance procedures. These are provided for possible reference and inclusion in operating procedures.


Operational and maintenance procedure

Procedures to be included in action plans or operating standards associated with this STANDARD include:

- a. Good housekeeping practices in refuelling bays.
- b. The safe operation of fuel transfer systems.
- c. The refuelling of vehicles, equipment and fixed plant.
- d. Fuel transfer between storage systems.
- e. Replacement or changing of fuel cells or storage tanks.
- f. The installation, location and maintenance of signage.
- g. Management of data pertaining to vehicle and equipment maintenance.
- h. Performing planned maintenance inspections and servicing of fuel transport and filling equipment.
- i. Report on equipment condition and maintenance effectiveness and standards.

As part of the maintenance system, procedures will be implemented that incorporate the following to reduce fire risk:


- a. Daily equipment servicing should include the removal of excess flammable materials (e.g. oil, grease) from the equipment before it is operated.
- b. Maintenance work on equipment should include the removal of excess flammable materials (e.g. oil, grease) from the equipment before it is operated.
- c. Immediate stopping of any equipment that develops a condition where heat sources or fuel sources may lead to a fire. These should be rectified and repaired before further operation. This procedure should be included as part of the induction training program for engineering employees.
- d. Daily services should ensure that lubricant and coolant levels in mobile equipment and fixed plant are adequate.

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- e. Any maintenance work undertaken involving the use of oxy-acetylene equipment should be undertaken in a designated “Hot work Areas” or subject to a “Hot work Permit.
- f. Injector lines should be changed out at intervals as per the mine standard or as per OEM specification. Injector pipes should not be re-used unless they have been subjected to and passed an NDT (full name) inspection. Where this cannot be guaranteed, new pipes should be used.
- g. A daily inspection of mobile equipment should include the following.
 - A check for oil and fuel leaks
 - A tyre inspection and pressure test
 - Checking the integrity of the turbocharger and manifold guards. (Retrofit kits for older machines to minimize lines and hoses in hot zone where available); and
 - An inspection of wiring systems.
- h. Thermostats on electrical motors should be tested at least monthly.
- i. A 250-hour inspection of mobile equipment should include the following inspections:
 - All sources of heat and all flammable materials
 - “V” Belts (and adjustment, where required)
 - Park brake operation
 - Battery compartments
 - Lube lines and fittings and
 - Fire suppression systems.
- j. Brakes should be dynamically tested at least as per OEM and mine standards, with visual inspection for excess wear on a regular basis.

Mobile equipment maintenance procedures (both rail bound and trackless transport machinery) should include:

- 1) Monthly inspections of extra low voltage wiring to OEM requirements.
- 2) Standard procedure for the lubrication of equipment.
- 3) A procedure that requires maintenance personnel to remove excess lubricants and flammable materials following maintenance activities. This should be recorded as part of the maintenance report.
- 4) Running-up all equipment to normal operating temperature (20min) inside the maintenance area before being returned into service.

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- 5) Maintenance inspections should identify leaks on equipment, which shall not be operated until these are repaired satisfactorily.
- 6) Inspection of hydraulic and fuel hoses for damage and wear at least every 250hrs. These should be replaced where required. Specific hose check sheets should be developed for each class of machine as part of this process. Unplanned changes in hose specification and routes should be avoided.
- 7) Ensuring no overloading of tyres and correct tyre inflation pressure.
- 8) Where Auto-fire suppression systems is used, fire extinguishing media will comply to one of the following specifications:

Auto fire suppression media must comply with the following, as applicable:

- ISO 7202 Series — Fire protection — extinguishing media — powder.
- EN 1568 Series — Foam concentrates for firefighting applications.
- NFPA 11 — Standard for low-, medium-, and high-expansion foam.
- UL 162 — Standard for foam equipment and liquid concentrates.
- NFPA 17 — Standard for dry chemical extinguishing systems.
- NFPA 17A — Standard for wet chemical extinguishing systems.
- ISO 14520 Series — Gaseous fire extinguishing systems.
- The manufacturer's specifications and certification requirements for the installed automatic fire suppression system.

The selected fire suppression agent must be compatible with the protected equipment, identified fuel sources, environmental conditions, and the fire risk assessment. All fire suppression systems must be installed, tested, inspected, and maintained by competent personnel in accordance with applicable regulatory requirements, manufacturer specifications, and recognized international standards

- 9) Explosives-carrying equipment should not be allowed into maintenance areas until all explosives and detonators have been removed and washed down.

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The standard addresses the following relating to electrical equipment maintenance:


- 1) Electrical equipment maintenance is included in a formal maintenance plan or schedule.
- 2) Only non-flammable sprays are to be used during electrical maintenance.
- 3) Only competent persons will do electrical maintenance work.
- 4) Modifications to an electrical equipment or reticulation systems will only take place with the approval of an electrical engineer or a statutory appointed person (e.g. Electrical Supervisor).
- 5) New installations shall be tested to the requirements of OEM and checked for compliance with fire prevention controls (refer Section 2.3) prior to being commissioned.
- 6) Thermal imaging surveys of Higher Voltage cable joints and appliance should be conducted every 12 months.
- 7) Electrical appliances in 'significant fire risk' locations (e.g. workshops, refuelling bays, etc.) will be inspected on monthly basis.
- 8) The maintenance system shall ensure continuing compliance with IP 55 Monthly inspection and testing of all electrical equipment associated with explosive storage facilities.

Maintenance procedures, including regular inspections:

- (i) Fuel storage systems.
- (ii) Fuel distribution systems.
- (iii) Fuel nozzles and connections.
- (iv) Spillage fuel containment systems (e.g. bunds, drains, sumps, etc.)

The following pre-use checks by equipment operators will include the following:

- 1) Integrity of wiring systems.
- 2) Tyre condition and damage (including rocks jammed in treads).
- 3) Presence of fuel or oil leaks.
- 4) Excessive lubricant level.
- 5) The presence of rags and flammable materials (e.g. paper).

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- 6) Condition of fire extinguisher and fire suppression system (e.g. charged or uncharged).
- 7) For heat sources and flammable materials (e.g. no combustible material in contact with lights).
- 8) The outlets from the operator’s cab are clear and useable.

The results of pre-use checks are recorded (e.g. using a checklist) and any defects recorded by the operator. Any dangerous (A-hazard) condition will be reported immediately to the supervisor and equipment use will be suspended until condition is rectified.

Completed pre-use check sheets will be provided to maintenance personnel and any defects recorded in the maintenance system.

All operators will be trained in the pre-use checks at induction.

The following are suggested practices for “hot work” activities:


“Hot work” is defined as the use of thermal cutting equipment, grinding equipment, arc welding equipment, heating devices, naked flames, or mechanical friction devices.

This must be performed in accordance with the Chief Inspector of Mines Directives.

A mine should designate areas where hot work may be performed, such as a welding bay in a workshop. In these areas a general risk assessment should be conducted, and all the identified controls applied.

Hot work can be conducted in these areas without a permit only if the appropriate controls are implemented. Any hot work in other areas should be controlled through the hot work procedure and associated permit.

A hot work permit system shall be applied for any such activity in any part of a mine outside a designated hot work area. The system should be based upon a procedure that at least include but not limited to the following requirements.

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The work or procedure will be authorized by an Engineering and Safety Department:

- The provision of adequate flash-back arrestors for Oxy/acetylene equipment.
- Inspection of the equipment for potential fuel sources prior to work commencing (“pre-work” inspection) must be performed.
- The removal of any flammable materials in the immediate vicinity of the hot work site before the commencement of any work.
- The provision and availability of fire extinguishers or other fire-fighting equipment in the immediate vicinity of the hot worksite.
- An adequate fresh air flow is present at the hot work site. Hot work shall stop in the event of any detectable weakening or stoppage of fresh air flow.
- The use of an observer or fire-watch, where required.
- A thorough inspection of the equipment and work area after work has been completed (“post-work” inspection).
- All precautionary measures relating to the transport and storage of gas cylinders should be followed prior to and following the completion of hot work.
- Use of the appropriate permit form or sheet and follow the standard procedure to record that the above checks have been undertaken.

13. PURCHASING PROCEDURE

The standard includes the requirement that the mine’s purchasing procedures be developed and implemented to ensure that any machinery, equipment, or materials purchased for use at the mine comply with site standards. This procedure:

- a. Manufacturers or suppliers to provide evidence that fire risks associated with such machinery, equipment or materials have been considered and addressed in compliance with applicable at least national standards.

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- b. Manufacturers or suppliers to make mine management aware of any residual fire risk, either patent or potential that might be associated with the use of such machinery, equipment, or materials.
- c. Manufacturers or suppliers of machinery to advise mine management of any fire-fighting equipment or additional fire protection requirements associated with the use of such machinery at a mine.
- d. Ensure that SDS's are provided for any combustible or flammable materials supplied to the mine.
- e. Manufacturers or suppliers of machinery or equipment provide adequate information on the operational procedures and maintenance requirements, particularly relating to any specific fire-detection or fire-fighting equipment custom built into the machinery. Alternatively, requirements and specifications for such fire-detection or fire-fighting equipment that might have to be provided separately by a third party need to be communicated adequately.
- f. Manufacturers or suppliers of machinery or equipment provide adequate training and/or training material to ensure the proficiency of machinery or equipment operators; and
- g. Ensure that machinery and equipment specifications and maintenance and operational manuals are included in tender documents for any new contracts.


14. INSPECTION

The standard reflects the requirements of the Mining Act that:

“The employer must ensure that a competent person reports to the employer, at appropriate intervals determined in accordance with the mine’s risk assessment, on –

- (a) The effectiveness of the precautionary measures taken to prevent or suppress explosions of coal dust or flammable gas; and
- (b) The adequacy of measures in place to prevent, detect and combat the start and spread of mine fires.”

The standard includes the requirement that a series of inspections relating directly to fire hazards be performed as follows:

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- a. Fire hazard audits: Intervals will be stipulated in accordance with section 8.1.1 of this guideline.
- b. Regular inspections of working areas to monitor compliance with fire controls, including preventative procedures and fire protection equipment; and
- c. Inspections aimed at identifying either substandard acts or work practices (behaviour) and substandard conditions (fire hazards). There are usually two types of inspections:
 - Formal inspections of all workplaces that are undertaken on a regular (i.e. weekly or monthly) basis, depending on the level of risk (e.g. weekly explosives magazine inspections). Formal inspections generally involve the use of area-specific or task specific checklists to record any defects; and
 - Informal inspections that are undertaken by employees, supervisors, and managers daily

Annexure 8: Inspections provide guidance for consideration during inspections.

15. AWARENESS TRAINING FOR FIRE PREVENTION

During employees' Induction Training, and refresher training that are conducted annually, all employees will receive training on Basic Fire Fighting equipment and the use thereof, any specialized training required by the OEM will have to be done by the OEM. Proof of such training will be available in the Employees Training file and Employer Training Matrix.

Machine and plant operators are training during Induction or refresher training and when the operator License is to be renewed.


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Type of Training	Type of Training	Occurrence	Sequence
General Fire Prevention Awareness	Theoretical Awareness and Practical Demonstration of the usage of Fire Preventions Equipment	Induction and Refresher Training	Annually
Mobile equipment Operators Training	Theory and Practical Training on Hazards and Risks, Fire Prevention Equipment, and inspection of equipment.	Induction, Refresher Training and Re-licensing	Annually
Fixed Plant Operator Training	Theory and Practical Training on Hazards and Risks, Fire Prevention Equipment, and inspection of equipment	Induction and Refresher Training	Annually
Mobile Equipment Maintenance Awareness	Theory and Practical Training on Hazards and Risks, Fire Prevention Equipment, and inspection of equipment	Induction and Refresher Training	Annually
Electrical Maintenance Personnel	Theory and Practical Training on Hazards and Risks, Fire Prevention Equipment, and inspection of equipment	Induction and Refresher Training, OEM Training	Annually
Fuels Storage Operational Personnel	Theory and Practical Training on Hazards and Risks, Fire Prevention Equipment, and inspection of equipment	Induction and Refresher Training	Annually

16. FIRE PROTECTION AND EMERGENCY RESPONSE

The standard reference broadly the mine's fire-protection and emergency response tactics for major fire hazards. This standard will describe the principles used in the selection of each tactic, the alignment of this with the respective fire risk assessment and any specialist input made in devising the protective measures and responses (e.g. fire engineering criteria to determine fire-fighting equipment specifications were deemed necessary, etc.).

Under this section, the standard list and describe briefly the measures implemented for early detection of fires at different locations on the mine-based list of fire hazard locations referenced in section

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Fire prevention measures as intended in this standard is a proactive endeavour aimed at eliminating the hazard of fire and should therefore be considered as the primary form of control. Fire protection is a secondary control aimed at reducing the consequences of a fire by limiting the severity and impact of a fire. Therefore, this guideline should be used in conjunction with the Guideline for emergency preparedness and response to provide a comprehensive and coordinated approach in addressing the fire prevention measures and control of fires.


Once fire risks have been assessed and controls determined, the information relating to the management of fires be consolidated into an underground fire control plan. This plan outlines the fire risks present at the mine and the activities and measures the mine is undertaking to control the risk of underground fires.

The objective of the fire control plan is to ensure the systematic planning and effective implementation of fire control systems. It is also a useful document for communicating to workers how fire risks are being managed.

The information contained in the plan will include:

- Infrastructure and facilities
- Details of underground fire risks (based on a formal risk assessment)
- Details of fire prevention controls
- Details of contingency controls
- A list of operating and maintenance procedures relating to fire control
- The fire hazard reporting procedure
- Provision and testing of alarm systems
- The emergency response procedure
- The training of employees in emergency procedures, firefighting, mine rescue and other relevant emergency response functions
- Details of inspection and auditing programs specific to monitoring fire controls
- A system to regularly review, update and communicate changes to the plan.

Responsibilities and accountabilities for monitoring, reviewing, and responding to reports will be clearly defined and assigned.

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Mock emergency drills will be regularly undertaken to test and improve the plan. This is vital to ensure competence across all areas of mine emergency response.

It is a regulatory requirement for mines to be prepared to respond to potential emergencies such as fires.

Effective means of monitoring and communicating the possible presence of a fire.

The standard sets out measures to monitor and communicate the possible presence of fire. This system should include the following:

Method(s) employed to detect the occurrence of a fire, presence of noxious gasses or flammable gasses underground.

Use of portable gas monitors:

Approved, portable gas monitors may be handheld, and are used to provide a Continuous reading of the underground atmosphere and warn with visible and audible alarms when levels are reached.


Approved portable gas monitors should be used:

- a. Within the distance between the face and the inlet of the ventilation ducting if the face is ventilated in exhausting mode; or
- b. At any auxiliary ventilated place where mine workers continuously work during any work activity.
- c. Any place where a seal is constructed to isolate a worked-out area during any work activity.
- d. Suitable extension probes should be readily available for use with handheld gas detectors to test for methane layering or accumulations in cavities and voids.

Smoke detectors:

Smoke detectors identify and provide a warning when particles of smoke are detected in a mine atmosphere.

Detectors are prone to dust build up and should be cleaned regularly to ensure they function correctly.

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Carbon Monoxide detectors (ppm):

Carbon monoxide monitors measure CO levels and sound an alarm before dangerous levels accumulate. CO monitors can detect the onset of fire through spontaneous combustion – events that can both be disguised by the running of diesel-powered vehicles and the use of explosives (which can lead to poisoning of the CO monitors).

The positioning of CO monitors or tube bundle sample points is critical to the quality of the data collected and how it is reported and interpreted.

If a monitor is positioned too close to the potential source/location to be monitored, it may not be in the main airstream resulting in the combustion products evading the monitoring instrument.

If a monitor is positioned too far away, the time it takes for the incident to intensify may be quicker than it takes for the contaminated air to travel to the site of the monitor.

Airflow monitors (m/s)

Airflow monitors are used to measure:


- Air velocity of air going into main surface fans.
- Air velocity at the out-bye end of the districts.
- Air velocity in an auxiliary ventilation duct or tube (i.e. pilot tube type).

Methane monitors:

Portable GDI's will be used to detect the presence of Methane.

Monitors for other gases:

Monitors used to detect other gases that might be present underground (such as radon, hydrogen sulphide, hydrogen, nitrous oxide, sulphur dioxide and nitrogen), include automatic detectors, tube bundle systems, handheld monitors, dosimeters, chemical detector tubes and gas chromatographs.

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Action to be taken when beacon head alarms:

When an alarm sounds for the possibility of a fire from a CO or smoke sensor, the control room operator will immediately via the radio system contact the nearest supervisor to confirm the presence of a possible fire.

The supervisor will immediately withdraw all employees to the nearest refuge bay and confirm the presence of a fire to the control room.

The control room operator will immediately warn all employees via the radio system of a fire upon which each supervisor will withdraw their employees to the nearest refuge bay to await further instructions.


The control room operator will phone or contact the Mine Overseer on duty and report to the Mine Manager.

The Mine Manager will activate the emergency response plan.

Airflow monitors (m/s):

Airflow monitors are used to measure:

- Air velocity of air going into main surface fans.
- Air velocity at the out-bye end of the districts.
- Air velocity in an auxiliary ventilation duct or tube (i.e. pilot tube type).

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Pressure transducers (Pa or kPa):

Pressure transducers are used to measure:


- Static pressure at main surface fans to alarm at $\pm 10\%$ of normal pressure.
- The pressure difference across a set of doors usually sited between intake and returns near to the working face. It will give an indication of the pressure variance as operations are conducted on the district.
- The static pressure of an auxiliary fan giving an indication if the fan is operating and if the ducting is damaged or restricted.
- On methane drainage ranges:
 - The vacuum being applied to the district.
 - The differential pressure across an orifice plate to determine the district flow.
- Across a working panel/roadway where the resistance is known.

Automatic fire detection systems installed in areas where there is a significant fire risk will provide an early warning.

Such areas include:

- Explosives bays
- Battery bays
- Compressed gas storage
- Fuel storages, refuelling bays, and transfer equipment.
- Combustible material storage areas
- Conveyor haulage
- Power sub-stations, Mini-substation, and oil-filled transformers

Smoke detection systems placed at the top of vent rise systems can provide a general fire warning.

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Continuous thermal monitoring should be installed and maintained on fixed plant where the operation of such equipment poses a significant fire risk underground.

Sensors use to monitor the air flow in underground workings effectively for detecting the presence of a fire and facilitate its location in the mine.


Positioning of CO monitors and smoke detectors:

Depending on the depth and length of mine or tunnel, and the location of conveyors, electrical equipment, hydraulic systems and the ventilation velocity, the employer should ensure that monitors or detectors are positioned:

- a. Before the commencement of a working face, unless there is a belt drive sited in that area.
- b. On the downstream side of any belt drive.
- c. Against the auxiliary fan, or in a position that will alert mine workers in a blind heading of a fire developing in a part of the mine or tunnel used to supply the blind heading with fresh air.
- d. In the return from the main working face.
- e. At the point where return airways form a single tunnel or if multiple main returns, then in each main return.
- f. At the outlet side of any underground main fan or booster fan.
- g. At any other location where a risk assessment identifies it as a requirement.
- h. In the flow path as indicated by a smoke test. The smoke test should be conducted prior to installation and again on commissioning.
- i. To ensure correct positioning is maintained, the tests should be re-taken when there is any significant change in airflow (+/- 20%) at that location.

Monitoring of air velocity, quantity, and quality:

Arrangements are in place to monitor air velocity, quantity, and quality, and that any significant changes to the following are investigated immediately:

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- Air velocity, quantity and quality at all critical locations as required by the ventilation system plan.
- Total air quantity at the main fan, and booster fans.
- Ventilation distribution.

Monitoring for the early detection of fire:

- Suitable monitors must be installed underground to alert employees in the vicinity of the early onset of fire.
- A monitoring and review process, including visual inspections and regular auditing, is implemented at the mine or tunnel.

Channels of communication after a fire has been detected.

Refer to Tembo Nickel's Procedure for Emergency Preparedness & Response.


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17. IMPLEMENTATION PLAN

This Mandatory standard is on schedule for implementation after being presented to the Health & Safety Committee for acceptance and signature and upon approval of the standard by the Tembo Nickel's General Manager.

The implementation programme of this standard can best be explained with the following table indicating the organisational structures, responsibilities of functions and schedule period.

Organisational Structures	Responsibilities of Functionaries	Schedule Period
System Administrator / Document Controller	<ul style="list-style-type: none"> Compile the standard into a standard format and distribute for comments and approval. Update the previous standard with the reviewed document and published. 	2 Years
Mine Manager / Tembo Nickel's Mine Board	<ul style="list-style-type: none"> Ensure that statutory requirements relevant to Fire Prevention at TCL are complied with. Approve reasonable allocation of budget for Fire Prevention control measures in each financial year's budget. 	Annually
Line Manager / Supervisor	<ul style="list-style-type: none"> Ensure that all employees working under their supervision have the necessary training on this STANDARD and all requirements are always adhered to. Ensure all firefighting equipment is maintained in good order and readily available in any cases of fire emergency. 	As required.
Employees	<ul style="list-style-type: none"> Follow safe work practices for Prevent Fires. Wear PPE devices where indicated. Report fire hazards and PPE problems to their immediate supervisor. Store and maintain PPE devices in a clean and hygienic manner. Attend Fire awareness and education programs as required. 	Annually As need arise
Safety Manager and Safety Officers Safety Reps	<ul style="list-style-type: none"> To acknowledge and sign the Mandatory STANDARD. To carryout periodic audits Carryout Toolbox Talks Workplace Inspections Recording of any incidents by all employees Make sure that all employees are provided with PPE when required. Set an example by always wearing PPE when required. Enforce the use of PPE and/or Prevention of Fire procedures and take appropriate disciplinary action in the event an Employee does not comply with this requirement. 	Initial, Annually or as need arise.

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ANNEXURE 1: Generic notes on fires

(For information purposes)


‘FIRE TRIANGLE’ (Oxygen, Heat, Fuel plus Chain Reaction) **fires** start when a flammable material or liquid, in combination with a sufficient quality of an oxidizer such as oxygen gas or oxygen-**risk** air is exposed to a source of heat or ambient temperature above the flash point for the fuel/oxidizer mix, and is able to sustain a rate of rapid oxidation that produces a chain reaction.

“Four (4) stages of a fire” By most standards including **IFSTA**, there are 4 stages of a fire. These stages are incipient, growth, fully developed, and decay. The following is a brief overview of each stage.

Incipient – This first stage begins when heat, oxygen and a fuel source combine and have a chemical reaction resulting in fire. This is also known as “ignition” and is usually represented by an exceedingly small fire which often goes out on its own, before the following stages are reached. Recognizing a fire at this stage provides the best chance at suppression or escape.

Growth – The growth stage is where the structures, fire load and oxygen are used as fuel for the **fire**. There are numerous factors affecting the growth stage including where the **fire** started, what combustibles are near it, ceiling height and the potential for “thermal layering”. It is during this shortest of the 4 stages when a deadly “flashover” can occur: potentially trapping, injuring or killing fire-fighters.


Fully Developed – When the growth stage has reached its maximum and all combustible materials have been ignited, a fire is considered fully developed. This is the hottest phase of a fire and the most dangerous for anyone trapped within.

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Decay – Usually the longest stage of a **fire**, the decay stage is characterized a significant decrease in oxygen or fuel, putting an end to the **fire**. Two common dangers during this stage are firstly – the existence of non-flaming combustibles, which can potentially start a new **fire** if not fully extinguished. Secondly, there is the danger of a back draft when oxygen is reintroduced to a volatile, confined space. received by employees will be kept on the employee’s files at the Training Office.

- 1.1.1. Class 0: liquefied petroleum gases (LPG).
- 1.1.2. Class 1A/B: liquids with a closed-cup flash point below 23 °C.
- 1.1.3. Class 1C: liquids with a closed-cup flash point between 23 and 38 °C.
- 1.1.4. Class 2: liquids with a closed-cup flash point between 38 and 60, 5 °C.
- 1.1.5. Class 3A: liquids with a closed-cup flash point between 60, 5 and 93 °C; and
- 1.1.6. Class 3B: liquids with a closed-cup flash point of 93 °C or above.

Physical and chemical properties of fuel sources can impact the level of a fire risk. These properties include flammability, ignitability, combustibility (fire spread capacity or fire-retardant effect), self-extinguishing properties, toxicity of paralysis products and other unique characteristics. Safety Data Sheets (SDSs) from suppliers in compliance with OSHA Act Global harmonized system of classification and labelling of chemicals and system or process design specifications from designers should be consulted to identify and categories fuel sources.

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ANNEXURE 2: Examples of fire hazards at mines

(For information purposes)


The following is a list of typical fire hazards that could be considered for addition in the standard list of fire hazards. The list is intended as an aide-memoire, and it is not exhaustive.

Underground


- a. Fixed mechanical equipment or plant using mechanical friction such as mono-winchers and associated winch rope systems, conveyor belt drives and pulleys.
- b. Fixed electrical equipment: electrical short circuits or over heating of oil-filled transformers or switchgear; (particularly where these are in main intake airway systems).
- c. Mobile equipment: fuel or oil leaks on hot exhaust manifolds or the surface of a turbocharger.
- d. Re-fueling bays and battery charging bays.
- e. Underground workshop areas (storage of fuels, grease, oils, paint, tires, hoses) in the presence of mobile equipment and also where extensive hot work is performed.
- f. Combustible and flammable liquid stores.
- g. Explosives storage areas.
- h. Locations where combustible flammable dust or gases can accumulate.
- i. Flame cutting and welding operations, particularly near combustible material.
- j. Abandoned panels or workplaces: spontaneous ignition of support timber or coal.

Surface

- a. Major transformer stations and electrical switchgear installations in or next to hoist rooms.
- b. Storage installations for fuel or other flammable chemicals.
- c. Overland conveyor belts.
- d. Coal stockpiles or spoil piles (induced fires or self-ignition).
- e. Explosives magazines.
- f. Smelter granulation or casting process areas.

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- g. Ammonia refrigeration plants.
- h. Waste storage or disposal areas.
- i. Natural or agricultural areas near, plant/surface infrastructure, intake shafts or declines (plant material fires)

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ANNEXURE 3: Mine infrastructure and fixed plant

(For mandatory purposes)


The following notes are provided for general guidance and possible consideration for addition in the structuring of action plans or of associated preventative measures.

Fixed plant

- a. Electrical cables and electrical equipment should be located so that they cannot be damaged by impact from vehicle collision or blasting in accordance with Tanzania Mining Regulations
- b. Fixed electrical installations should be designed to minimize the need for maintenance personnel to work on live apparatus
- c. Oil-cooled transformers' sites be built on a bonded floor, impervious to fuel and are provided with drainage facilities for handling spillage of cooling oil.
- d. These sites should be adequately protected from incidental damage caused by vehicle movement in the vicinity. This implies that sites should be adequately selected in relation to vehicle traffic flow and that the erection of bollards or barriers should be considered.
- e. Reflectors should be attached to fixed electrical installations and cables to make them clearly visible to operators.
- f. Thermostats should be provided on electrical motors to stop the motor being governed automatically if pre-set temperature requirements are exceeded.
- g. A minimum of two fire extinguishers rated for the classification of fire for which it is to be used must be provided for substations and transformers. For sub stations one should be located on the inside of the sub and the other on the outside of the substation in an upwind position. Transformers should have a fire extinguisher on either side located as close as practical to the entry. Newly designed mines should make provision for underground substations with oil-filled equipment should be ventilated to the return airway when a fire occurs and have automatic fire extinguishing equipment.
- h. Electrical protection against earth leakage and overload should be provided for all fixed mechanical equipment and electrical Trackless Mobile Machines. These installations should be designed in such a manner so as to prevent a temperature rise in the cables that could lead to a fire.
- i. Critical items of plant that are associated with potential fuel sources should have thermal monitoring installed.
- j. All materials used in the construction of fixed mechanical equipment should be flame retardant.

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- k. Equipment should be designed to minimize the need for welding and flame cutting underground or in confined spaces.
- l. Hydraulic and lubrication systems should use steel piping wherever possible. Where hoses are used, they should be.
- m. Belt drift switches should be provided to stop the belt if excessive drift is detected.
- n. Fluid couplings if used should not be source of ignition.
- o. Idler bearings should be sealed.
- p. Temperature monitoring devices and alarms should be installed, in readily identifiable locations, on main bearings of conveyor drives.
- q. Where possible, compressors should be located on the surface rather than underground.
- r. Compressors should be designed so that in the event of a compressor fire, the amount of smoke entering the main intake is minimized.
- s. Where compressors are operated underground, consider the following:
 - i. Thermal monitoring devices should be installed on the output of the compressor screws that alarm and stop the compressor in the event of a temperature or oil pressure overload or high discharge air temperature being detected; and
 - ii. Compressors should be installed so that the ventilating air flows over them directly to return.
- t. Flow switches should be provided to stop pumps in the event of low flow conditions.

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ANNEXURE 4: General design requirements: Mobile equipment
(For mandatory purposes)


The following is a series of technical solutions that might be considered in addition in mine’s action plans and/or as part of the standard. This includes but is not limited to the following:

Vehicles


- a. An adequate number of fire extinguishers adequate for the classification of fire for which it is to be used must be provided for each vehicle.
- b. In addition to the above, large mining vehicles used for ore loading and transport should be provided with custom-designed on-board fire suppression equipment.
- c. Where a vehicle has to pass under a power line, the line should be raised to provide clearance in accordance with Mining Regulation.
- d. In relation to the layout of equipment in engine bays, the following should be considered in relation to hydraulic hoses:
 - i. Hydraulic hoses should be flame retardant and meet the requirements as per TNCL Standards.
 - ii. Securely clamped away from hot surfaces.
 - iii. Located so that impact damage is minimized; and
 - iv. Provided with bulkhead fittings where they pass through bulkheads.
- e. Flammable fluid containers should be located such that any overflow should not contact a potentially hot surface.
- f. Secure filler caps should be provided that include tie traps.

Engine systems

- a. Consider the use of powering-down systems to stop engines safely in the event of an emergency.
- b. Engine control systems should be designed so that the fuel system would be shut off automatically if a fault occurs that requires the engine to stop.
- c. Adequate protection must be provided where this equipment is operated in explosive gas dust atmospheres, Compression-ignition engine systems and machines powered by such engine systems, for use in mines and plants with explosive gas).
- d. The introduction of operational or automatic means for shutting down engines when working pressures exceed recommended maximum values should be considered.
- e. Bulk heads should be fire-proof.

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- f. Consider installing fire monitoring sensor sat points where the temperature of the hottest part of a diesel engine exhaust system and retarders can be measured as per standard: Compression-ignition engine systems and machines powered by such engine systems, for use at mines and plants with explosive gas atmospheres or explosive dust atmospheres or both Part 1-1: Fire hazardous locations in underground mines – basic explosion protected engines.”
- i. Part 1-2: Fire hazardous locations in underground mines – explosion protected engine systems.
 - ii. Part 1-3: Fire hazardous locations in underground mines – machines.
 - iii. Part 3-1: Fire hazardous locations on surface – basic explosion – protected engines.
 - iv. Part 3-2: Fire hazardous locations on surface – explosion – protected engine systems.
 - v. Part 3-3: Fire hazardous locations on surface – machines.
 - vi. Part 4: Non-fire hazardous locations in underground coal mines. Vehicle electrical **systems**
- a. Protection should be provided against short circuiting and overcurrent.
 - b. Electrical cables should be installed at safe distances from fuel lines.
 - c. Electrical systems should be designed to prevent the occurrence of electrical sparks following a system malfunction or accident.
 - d. Consider the use of electrical systems that derive power from diesel engine alternators or **batteries** for Earth-moving machinery and ancillary equipment for use in mines - electrical wiring systems at extra-low voltage standard.
 - e. Where jump-starting systems are used, they should be purpose-designed for all electrical start equipment and meet the requirements as specified by the mine’s engineer.
 - f. Where electrical cables and hoses are to pass through bulkheads, they should have rubber flame retardant connections (i.e. proper bulkhead connections) to which the cables and hoses are attached.
 - g. Protection against over current in low voltage (a nominal voltage level that are used for the distribution of electricity, the upper limit of which is an AC voltage of 1000V or a DC voltage of 1 500 V) circuits should be considered, where practical, by using circuit breakers or encapsulated fuses.
 - h. Consider protecting all circuits, except starter motors, against short circuit and over current.


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Vehicle fuel and hydraulic systems

- a. Consider using steel lines for fuels, hydraulic and exposed lubrication systems.
- b. Where flexible hoses are used, they should limit the spread of fires: Fire testing of materials, components and elements used in buildings – Part 9: small-scale burning characteristics of flexible hoses).
- c. Vent outlets or overflow points should be directed away from hot surfaces.
- d. Hoses, oil, fuel and hydraulics lines, and fittings should be installed as per OEM specifications, i.e. positioning of clamps, routing and length of hoses, replacement fittings and components.
- e. Fuel or oil lines or hoses should be kept separate from electrical cables.
- f. Fuel or oil lines or hoses should be routed away from moving parts.
- g. Fuel, oil and hydraulic systems and associated distribution lines should be free of leakages and protected from hot surfaces.
- h. The flash points of liquids used by mobile equipment should be below the maximum ambient temperature likely to be experienced.
- i. Hoses should be routed so that in the event of a burst or leaking hose, flammable liquid cannot come into contact with hot surfaces. Where routing away from hot surfaces is not possible, all hoses should be securely clamped and shielded so that in the event of a burst or leaking hose, flammable liquid cannot come into contact with a hot surface.
- j. Hoses to be:
 - Securely clamped away from hot surfaces.
 - Located so that impact damage is minimized; and
 - Provided with bulkhead fittings where they pass through bulkheads.
- k. Consider providing dry break filling connections where fuel tanks on vehicles are replenished in production areas or for vehicles that transport explosives.
- l. Containers for combustible fluids should be located so that any overflow cannot come into contact with hot surfaces. Where they are not provided with a dry break filler, they should be provided with secured filler caps that are permanently connected to the container.

Tires and power transmission

- a. Tires should be selected to suit their intended application in accordance with the OEM design and specifications.
- b. Consider fitting flame retardant “V” belts on mobile equipment.


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Other mobile equipment requirements

- a. Vehicle brake systems for mining equipment other than light vehicles (utility vehicles, small SUV small personnel carriers, etc.) should be equipped with enclosed brake systems; or, where open discs are installed, residual pressure monitoring, brake drag, or temperature monitoring and flame-retardant brake hoses should be considered.
- b. Ideally, all equipment functions, including the retarder function, should be monitored.
- c. A system that monitors engine oil pressure and stops the engine if pre-determined values are not maintained could be considered.
- d. Turbocharger lubrication lines should be made of steel. Flexible connections may be used provided they are fire retardant and located away from hot surfaces.
- e. The operator's cab should be provided with a fire wall to inhibit the passage of fire into the cab.
- f. Covers on engine compartments should be flame retardant.
- g. Vehicles transporting dangerous goods (define) should comply with national tanker standards.
- h. Vehicles transporting combustible liquids should comply with national tanker standards.
- i. Explosives should only be transported in separate enclosed compartments that meet the requirements of SAP Standard (Part 1: Explosives - storage and transport).
- j. Further information regarding fire prevention measures for mobile equipment can be found in the TMM and Rail Bound guidelines.

The standard should set measures for the operation of all classes of mobile equipment. These procedures should include provisions for the following:

- a. Testing of brake functionality by the operator.
- b. Correct brakes are used by the operator.
- c. Safe parking of the vehicle when a brake fault is detected.
- d. A vehicle with a flat tyre to be parked in the nearest safe and accessible place.
- e. Safe parking of equipment when "V" belt fault detected.
- f. Safe parking of equipment when tyre overheating, or tyre fire is suspected.
- g. The correct operation of retarder and equipment braking systems.
- h. The provision of self-contained self-rescuers.
- i. Housekeeping standards for operator cabs.
- j. Checking equipment before use for the presence of oil or fuel leaks, combustible materials (e.g. rags, paper) and tyre condition.


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ANNEXURE 5: General design requirements: Fuel storage areas, fuel transfer equipment and refueling bays.


(For information purposes)

The following is a series of technical solutions that might be considered in addition in the mine's action plans and/or as part of the standard. The inclusion of these suggestions in the standard is not mandatory. These suggestions are not intended to be complete or exhaustive:

- a. Electrical control systems associated with fuel transfer and storage should comply with the above-mentioned standard.
- b. High voltage reticulation should not pass through a fuel storage area; standard such as but not limited to: Identification and classification of fire hazardous substances, Transportation of dangerous goods, and: Electrical apparatus for explosive gas atmospheres for safe distance.
- c. Diesel storage tanks (fixed or mobile) should comply with the above-mentioned standard as appropriate and should be regularly inspected and maintained to ensure continuing compliance.
- d. Where a mine uses a surface to underground fuel delivery pipe, it should be:
 - Custom-designed;
 - Where possible, installed in an accurately drilled and surveyed borehole;
 - Where installed in a working shaft or material decline, it should be protected from incidental damage through contact with vehicles or moving conveyances;
 - Contained in a free draining borehole; and - Subjected to inspection and nondestructive testing at regular intervals; and
 - Provided with a system preventing "runaway" flow of fuel into the mine.
- e. Containers such as "Jerry cans" used for transporting fuel should be secured to the load-carrying area away from any potential impact damage.
- f. The storage of flammable gas cylinders should be separated from oxygen cylinders by a distance of at least 3m or have steel plate barrier at least the height of the flammable gas cylinders next to the oxygen cylinders.
- g. Appropriate signage should be installed at all entrances to fuel storage areas indicating:
 - Type and volume of fuel stored;
 - Prohibition of unauthorized persons;
 - Prohibition of smoking or naked lights;
 - Prohibition of any hot work; Requiring the shutting down engines before refueling; and
 - Emergency procedures in case of fire.
- h. All refueling points should be separated from any connected supply points using a physical barrier or adequate distances.


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- i. Any fuel supply or permanent refueling location should be capable of being effectively and safely isolated from the mine's ventilation system in the event of a fire or situated in a manner that smoke can be effectively directed into the return airway.
- j. Permanent storage, supply and refueling stations should have an automatic fire detection and suppression system that complies with relevant parts.
- k. Automatic fire suppression systems should include a fire alarm or other system to alert mine personnel in case of fire and be capable of being manually activated at a safe distance from the refueling bay.
- l. A minimum of two portable fire extinguishers with a suitable rating for the class of fire should be provided on the upstream side of all temporary fueling areas.
- m. Permanent fuel storage locations should be built on a bonded floor, impervious to fuel, and provided with drainage facilities for handling fuel spillage. Part 3: The installation, modification and decommissioning of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations, could be used as reference.
- n. These sites should be adequately protected from incidental damage caused by vehicle movement in the vicinity. This implies that sites should be adequately selected in relation to vehicle traffic flow and that the erection of bollards or barriers should be considered.
- o. Where a fuel storage location is temporary, a risk assessment that deals with fuel spillage should be conducted and control measures as identified by the risk assessment are implemented.
- p. All equipment used to store, transfer or distribute fuel should meet all the relevant sections of Mining Standards, "The petroleum industry Part 3: The installation, modification and decommissioning of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations.
- q. Storage tanks, pipe work and fuel transport vehicles entering refueling bays should be earthed in accordance with the standard. The petroleum industry - Part 3: The installation, modification and decommissioning of underground storage tanks, pumps/dispensers and pipe work at service stations and consumer installations to dissipate static electrical charge.
- r. All fuel transfer systems should be constructed with non-flammable materials and brass or non-metallic components and automatically shut off to stop flow.
- s. Where practical, in underground applications, steel fire doors should be constructed to seal off the refuelling bay area to prevent smoke entering intake airways in the event of a fire.
- t. No vehicle should park in a refuelling bay except for the purposes of refuelling or unloading of fuel.
- u. Refuelling bays should be provided with adequate facilities (e.g. water hose, absorbent material) to quickly contain or clean-up any fuel spillage.

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- v. Any waste (e.g. soiled absorbent material) should be placed immediately in clearly marked receptacles and well away from any potential ignition source. These receptacles should be emptied at least weekly.

- w. Electrical equipment, including lights, should meet the wiring requirements of Wiring of premises – Part 1: Low voltage systems.

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ANNEXURE 6: Safe use, transport and handling of explosives

(For mandatory purposes)

The following is a series of technical solutions that might be considered for addition in mine's action plans and/or as part of the standard. This includes but is not limited to the following:

Explosives storage containers

- a. Explosive storage containers should be located away from main travelling ways to minimize the potential impact of explosion due to fire (Regulation 4.2).
- b. A water hose and proper drainage should be installed to allow for hosing down of spilt product or combustible liquids (e.g. oil leaking from explosives vehicles).
- c. Appropriate signs should be installed on all explosive storage containers indicating:
 - No smoking, naked lights or equipment within 8 meters of explosives; and
 - The emergency procedure in case of fire.
- d. Formal housekeeping requirements should be implemented to ensure that no waste material is allowed to accumulate in the area where explosive storage containers are located.
- e. Operating procedures should be developed for the safe storage and transport of explosives to reduce the risk of fire involving explosives. These procedures should include provisions for the following:
 - Safe refueling of vehicles carrying explosives (consideration should be given to removing explosives from the vehicle before refueling).
 - Only purpose-designed and constructed explosive-carrying equipment entering magazines.
 - Access to explosive storage facilities including loading and unloading vehicles carrying explosives, at the explosive storage facilities or elsewhere;
 - Vehicles carrying explosives being parked in designated areas that prevent uncontrolled access while left unattended;
 - Non-bulk explosives (e.g. detonators, primer plugs, boosters etc.) to be transported in;
 - Separate enclosed compartments that meet the requirements of the Explosive Act (Part 1 Explosives -Storage and Transport);
 - All procedures relating to the storage and transport of explosives should meet the Mining Standard.

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Prohibition requirements

Procedures should prohibit:


- a. Access to explosive storage facilities except by purposely designed vehicles and only for the purpose of loading and unloading:

- The presence of ignition sources including mobile and satellite phones, smoking, cigarette lighters and matches on or around explosives carrying machines, or in or around explosive storage facilities, explosives carrying machines and service equipment;
- Diesel engines running whilst loading or unloading in an explosive facility;
- The presence of flammable goods in operators' cabins of vehicles conveying explosives;
- Explosives carrying vehicles into maintenance areas prior to there having been washed down;
- Hot work on or around vehicles carrying explosives and detonator until these have been removed, washed down;
- The transport or storage of diesel around or into an explosive storage facility;
- The transport or storage of flammable gases around or in explosive storage facilities;
- Vehicles parked at a safe distance from explosive or other combustible materials (e.g. empty cartons) when inside explosive storage facilities; and
- People attempt to fight an explosives fire with portable extinguishers except to extinguish a small equipment or waste fire not involving explosives.

Other requirements


- a. In addition to training requirements provided for Mobile Equipment Operators, personnel who transport explosives or handle explosives inside explosive storage facilities should also be trained and assessed for competency in at least the following:

- Procedures for transport and handling of explosives;
- Explosive fire prevention measures and response;
- Refueling of explosives carrying vehicles;
- Access requirements for explosive storage facilities; and

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b. The following supervisory activities are recommended:

- Checks for the presence of correct signage (e.g. “Flammable materials”, “No Smoking”, “Explosives” etc.);
- Compliance with maintenance procedures;
- Pre-handover inspection on machine cleanliness;
- Checks for adequate fire protection (e.g. enough and correct type of fire extinguishers).
- Checks of emergency equipment such as refuge chambers and the status of escape ways;
- Layout of the explosive storage facilities (segregation of the explosives, detonators and bulk explosives);
- Safe parking of explosive-carrying equipment;
- Cleaning of explosives carrying equipment prior to hand-over to maintenance; and
- Specific emergency response procedures for explosive storage facilities or explosive- carrying equipment.

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ANNEXURE 7: Generic operational and maintenance procedures

(For information purposes)


The following is a series of technical solutions that might be considered in addition in mine's action plans and/or as part of the standard. This includes but is not limited to the following:

Procedures that could be considered for inclusion in action plans or operating standards associated with this standard include:

- a. Good housekeeping practices in refueling bays.
- b. The safe operation of fuel transfer systems.
- c. The refueling of vehicles, equipment and fixed plants.
- d. Fuel transfer between storage systems.
- e. Replacement or changing of fuel cells or storage tanks.
- f. The installation, location and maintenance of signage.
- g. Management of data pertaining to vehicle and equipment maintenance.
- h. Performing planned maintenance inspections and servicing of fuel transport and filling equipment.
- i. Report on equipment condition and maintenance effectiveness and standards.

As part of the maintenance system, procedures should be implemented that incorporate the following to reduce fire risk:


- a. Daily equipment servicing should include the removal of excess flammable materials (e.g. oil, grease) from the equipment before it is operated.
- b. Maintenance work on equipment should include the removal of excess flammable materials (e.g. oil, grease) from the equipment before it is operated.
- c. Immediate stopping of any equipment that develops a condition where heat sources or fuel sources may lead to a fire. These should be rectified and repaired before further operation. This procedure should be included as part of the induction training program for engineering employees.
- d. Daily services should ensure that lubricant and coolant levels in mobile equipment and fixed plants are adequate.
- e. Any maintenance work undertaken involving the use of oxy-acetylene equipment should be undertaken in a designated "Hot work Areas" or subject to a "Hot work Permit";

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- f. Injector lines should be changed at intervals as per the mine standard or as per OEM specification. Injector pipes should not be re-used unless they have been subjected to and passed an NDT (full name) inspection. Where this cannot be guaranteed, new pipes should be used.
- g. A daily inspection of mobile equipment should include the following:
- A check for oil and fuel leaks;
 - A tire inspection and pressure test;
 - Checking the integrity of the turbocharger and manifold guards. (Retrofit kits for older machines to minimize lines and hoses in hot zones where available); and
 - An inspection of wiring systems.
- h. Tests of temperature alarms should be conducted as per mine standard.
- i. Thermostats on electrical motors should be tested at least monthly.
- j. A 250-hour inspection of mobile equipment should include the following inspections:
- All sources of heat and all flammable materials;
 - "V" Belts (and adjustment, where required);
 - Park brake operation;
 - Battery compartments;
 - Lube lines and fittings; and
 - Fire suppression systems.
- k. Brakes should be dynamically tested at least as per OEM and mine standards, with visual inspection for excess wear on a regular basis.

Mobile equipment maintenance procedures (both rail bound and trackless transport machinery) should include:


- a. Monthly inspections of extra low voltage wiring to OEM requirements.
- b. Standard procedure for the lubrication of equipment.

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- c. A procedure that requires maintenance personnel to remove excess lubricants and flammable materials following maintenance activities. This should be recorded as part of the maintenance report.
- d. Running up all equipment to normal operating temperature (20min) inside the maintenance area before being returned back into service.
- e. Maintenance inspections should identify leaks in equipment, which shall not be operated until these are repaired satisfactorily.
- f. Inspection of hydraulic and fuel hoses for damage and wear at least every 250hrs. These should be replaced where required. Specific hose check sheets should be developed for each class of machine as part of this process. Unplanned changes in hose specification and routes should be avoided.
- g. Ensuring no overloading of tires and correct tire inflation pressure.
- h. Where Auto-fire suppression systems are specified, fire extinguishing media should comply to one of the following national specifications:
- i. Explosives-carrying equipment should not be allowed into maintenance areas until all explosives and detonators have been removed and washed down.

The standard should address the following relating to electrical equipment maintenance:

- a. Electrical equipment maintenance should be included in a formal maintenance plan or schedule.
- b. Only non-flammable sprays should be used during electrical maintenance.
- c. Only competent people should do electrical maintenance work.
- d. Modifications to electrical equipment or reticulation systems should only take place with the approval of an electrical engineer or a statutory appointed person (e.g. Electrical Supervisor).
- e. New installations should be tested to the requirements of OEM and checked for compliance with fire prevention controls (refer Section 2.3) prior to being commissioned
- f. Thermal imaging surveys of Higher Voltage cable joints and appliances should be conducted every 12 months.
- g. Electrical appliances in 'significant fire risk' locations (e.g. workshops, refueling bays, etc.) should be inspected on monthly basis.
- h. The maintenance system should ensure continuing compliance with IP 55 Monthly inspection and testing of all electrical equipment associated with explosive storage facilities.

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The following should be considered to be formal maintenance procedures, including regular inspections:

- a. Fuel storage systems.
- b. Fuel distribution systems.
- c. Fuel nozzles and connections.
- d. Spillage fuel containment systems (e.g. bunds, drains, sumps, etc.).
- e. The following pre-use checks by equipment operators could include the following;
 - a. Integrity of wiring systems.
 - b. Tire condition and damage (including rocks jammed in treads).
 - c. Presence of fuel or oil leaks.
 - d. Excessive lubricant level.
 - e. The presence of rags and flammable materials (e.g. paper).
 - f. Condition of fire extinguisher and fire suppression system (e.g. charged or uncharged).
 - g. For heat sources and flammable materials (e.g. no combustible material in contact with lights).
 - h. That the outlets from the operator's cab are clear and useable.


The results of pre-use checks should be recorded (e.g. using a checklist) and any defects recorded by the operator. Any dangerous condition should be reported immediately to the supervisor, and equipment use should be suspended until condition is rectified.

Completed pre-use check sheets should be provided to maintenance personnel and any defects recorded in the maintenance system.


All operators should be trained or instructed in pre-use checks at induction.

The following are suggested practices for “hot work” activities:


- a. “Hot work” is defined as the use of thermal cutting equipment, grinding equipment, arc welding equipment, heating devices, naked flames or mechanical friction devices. This must be performed in accordance with the Chief Inspector of Mines Directive.
- b. A mine should designate areas where hot work may be performed, such as a welding bay in a workshop. In these areas a general risk assessment should be conducted and all the identified controls applied.

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- c. Hot work can be conducted in these areas without a permit only if the appropriate controls are implemented. Any hot work in other areas should be controlled through the hot work procedure and associated permit.
- d. A hot work permit system should be applied for any such activity in any part of a mine outside a designated hot work area. The system should be based upon a procedure that at least include but not limited to the following requirements.
- e. The work or procedure should be authorized by an appointed person:
- The provision of adequate flash-back arrestors for Oxy/acetylene equipment.
 - Inspection of the equipment for potential fuel sources prior to work commencing (“pre-work” inspection) must be performed.
 - The removal of any flammable materials in the immediate vicinity of the hot work site before the commencement of any work.
 - The provision and availability of fire extinguishers or other fire-fighting equipment in the immediate vicinity of the hot work site.
 - Adequate fresh air flow is present at the hot work site. Hot work shall stop in the event of any detectable weakening or stoppage of fresh air flow
 - Thermal blankets shall be provided to shield any exposed equipment where hot work is conducted particularly where this contains flammable constituents (focus on making available adequate means of extinguishing fire like water and water hoses).
 - The use of an observer or fire-watch where required.
 - A thorough inspection of the equipment and work area after work has been completed (“Post-work” inspection).
 - All precautionary measures relating to the transport and storage of gas cylinders should be followed prior to and following the completion of hot work.
 - Use the appropriate permit form or sheet and follow the standard procedure to record that the above checks have been undertaken.
- f. The maintenance of fire protection equipment should be undertaken in accordance with relevant procedures and standards.
- g. The level of (adequate) fire-fighting competencies required to help reduce fire risk should include:

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- All employees who work at the mine;
- Operators of mobile equipment and fixed plant;
- Employees involved in the transport or handling of explosives in magazines;
- Employees maintaining mobile equipment and fixed plant; and
- Electrical maintenance personnel.

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ANNEXURE 8: Inspections

(For information purposes)

All inspections should include but should not be limited to the following to help reduce fire risk:

- a. Compliance with explosives transport and storage procedures.
- b. The presence of No smoking or no naked flame signs in designated areas.
- c. Checks for flammable materials on equipment or in engine bays.
- d. Use of the hot work procedure and compliance with hot work permit requirements.
- e. Compliance with site housekeeping standards.
- f. Correct vehicle or parking requirements (e.g. only in designated areas).
- g. Compliance with combustible storage standards (e.g. in workshops and fuel storage areas).
- h. Competencies should be provided through competency-based training delivered through the site's training system. This system should include the proper recording of all training and competency assessments.
- i. The level of (adequate) fire-fighting competencies required to help reduce fire risk should include:
 - All employees who work at the mine;
 - Operators of mobile equipment and fixed plant;
 - Employees involved in the transport or handling of explosives in magazines;
 - Employees maintaining mobile equipment and fixed plant; and
 - Electrical maintenance personnel.

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RANKING								
No.	Activity / Condition	Hazards	Risk	Risk Classification P = Probability S = Severity SR = Significance Ranking			Controls <i>(Considered in the following order Elimination; Substitution; Eng Controls; Warning Signage; Admin Controls; Training; PPE)</i>	Residual Risk
				P	S	SR		
1	Ensuring that all tools and equipment being used are identified numbered and on register	<ul style="list-style-type: none"> ▪ Tools and equipment not identified, numbered and put on register ▪ Register doesn't comply to the legal requirements ▪ Fire hazard 	<ul style="list-style-type: none"> ▪ Liability claims from legal non-compliance ▪ Injury and property damage can occur from equipment that isn't working as a result of fire hazard. ▪ Failure of equipment can occur 	4	4	16	<ul style="list-style-type: none"> ▪ All equipment that is put on the register must be checked monthly by a responsible site official before the 7th and must be signed of before work can commence ▪ Where there is certificates required it will form part of the register ▪ All fire fighting equipment must be in proper serviceable condition at all times. ▪ Audits and inspections 	8
2	The responsible mine official must make sure that every employee has undergone proper training on the use of the equipment and emergency procedures	<ul style="list-style-type: none"> ▪ Incompetent personnel 	<ul style="list-style-type: none"> ▪ Serious injury can occur and or fatality ▪ Legal implications 	4	4	16	<ul style="list-style-type: none"> ▪ Proper training must be given to all employees before allowed to use the equipment. ▪ Appointed personnel must have proper certification ▪ All operators to be trained in basic fire fighting. ▪ Employees to observe section 22 and 23 of MHSA. ▪ PTO ▪ Supervision 	8
3	Risk assessment must be discussed, understood and signed prior to the work being done	<ul style="list-style-type: none"> ▪ Incompetent work force ▪ Poor risk assessment 	<ul style="list-style-type: none"> ▪ Exposure to legal liability ▪ People can get injured or killed. ▪ Legal claims 	4	4	16	<ul style="list-style-type: none"> ▪ All employees must make sure they understand the risk involved and sign the attendance register and the competent person must ensure that all personnel do risk assessment before work commences. 	10

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				P	S	SR		
4	There must be adequate equipment provided in the working area and must be situated in easy access areas	<ul style="list-style-type: none"> In adequate positioning of equipment and amount can cause a delay in response time in case of emergencies 	<ul style="list-style-type: none"> The effect of the fire can be worse if the response time is slow causing more injuries and even fatalities 	4	4	16	<ul style="list-style-type: none"> Ensure the proper signage is installed to indicate the placement of equipment and emergency escape routes. Ensure adequate amount of fire fighting equipment is available Inspections and audits 	8
5	Fire equipment must be unobstructed at all times	<ul style="list-style-type: none"> No availability of fire equipment or taking too long to access the equipment. Poor housekeeping 	<ul style="list-style-type: none"> Property damage can occur Serious injury or fatality can occur Trip and fall 	4	4	16	<ul style="list-style-type: none"> Ensure that the employees know where the equipment is stored Monthly inspections must be done and logged 	8
6	Correct equipment must be used for the job at hand	<ul style="list-style-type: none"> Use the correct extinguishing tools (Water fire extinguishers cannot be used for electrical fires) Substandard machines Poor maintenance of machines 	<ul style="list-style-type: none"> Injury can occur and or damage to property can be bigger Property damage or fatality as a result of fire. 	4	4	16	<ul style="list-style-type: none"> Make sure correct fire extinguishers are used for the job at hand Competent persons to ensure that all machines are maintained in good working conditions at all times. Employees to observe sect 22 and 23 of MHS.A. Supervision 	10
8	All combustible materials are to be removed while working before the end of every shift and correctly stored away from any structure	<ul style="list-style-type: none"> Ignition of combustible material 	<ul style="list-style-type: none"> Property damage can occur from exploding pressure vessels Serious injury can occur Fire 	4	3	12	<ul style="list-style-type: none"> Proper storage of combustible material must be done and supervised by the supervisor after every shift Good housekeeping to be maintained at all times. Supervision 	8

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No.	Activity / Condition	Hazards	Risk	Risk Classification			Controls <i>(Considered in the following order Elimination; Substitution; Eng Controls; Warning Signage; Admin Controls; Training; PPE)</i>	Residual Risk
				P = Probability	S = Severity	SR = Significance Ranking		
9	Cigarette ends must be carefully stubbed in the ash trays provided, and not thrown into rubbish bins	<ul style="list-style-type: none"> Burning cigarettes in the rubbish bins 	<ul style="list-style-type: none"> A fire can break out causing property damage or injury 	4	3	12	<ul style="list-style-type: none"> Only use designated smoking areas, make sure cigarettes are stubbed before throwing them in ash trays Coaching and training or smoking Policy. 	8
10	Sufficient exits need to be provided for employees in case of emergencies	<ul style="list-style-type: none"> Overcrowding at exit points during emergency. Employees not knowing fire procedures 	<ul style="list-style-type: none"> People can get trapped inside building which can result into serious injuries and or fatalities 	4		12	<ul style="list-style-type: none"> Ensure that all the exits are clearly visible. No equipment may be stacked in front of doorways or exits. Training and coaching 	8

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