Critical Activities Requirements - RAC

PNR-000069, Rev.10: 08/05/2024

Department Issuer: Health, Safety and Environment
Technical Responsible: Occupational Safety
Target Audience: All professionals working in Vale's Health and Safety area
Training Needed: ( ) YES (x) NO

Expected Results:

- To develop and improve existing requirements focusing on the pillar “Zero Lives Lost and Zero Lives Changed”.
- To consolidate the Critical Activities Requirements as a high-level document and global standard for application throughout Vale in all its business and processes.

Asssociation with VPS:

5 - Health, Safety and Enviroment

Purpose

To establish minimum requirements for performing critical activities to preserve people's lives.

Application

This document applies to Vale at a global level and must be adopted by its subsidiaries or entities where, by shareholders' agreement, Vale is responsible for Health and Safety management.

Important Definitions

- **Short term occasional access:** Uncertain and/or casual event, related to an urgent/emergency, where there is no prediction of recurrence.
- **Critical activity:** Activity that presents risks with potential to generate fatality or lives changed.
- **Qualified Professional:** Professional who has adequate experience and training to be considered competent to perform their duties in critical activities, considering relevant laws and internal guidelines.

Premise

This document establishes mandatory requirements that must be complied with in all areas and organizational processes, whether performed by Vale employees or by contractors, on the following subjects:

- RAC 01 - Working at heights
- RAC 02 - Light motor vehicles
- RAC 03 - Mobile equipment operation
- RAC 04 - Lockout, tagout and zero energy
- RAC 05 - Lifting of loads

- RAC 06 - Confined spaces
- RAC 07 - Machine guarding
- RAC 08 - Activities on the ground
- RAC 09 - Explosives
- RAC 10 - Working with electricity
- RAC 11 - Molten metal
- RAC 12 – Hot work
- RAC 13 – Line and equipment opening

The requirements of this document must be included in the control measures established within the area's risk management. However, the prevention of incidents related to critical activities is not limited to complying with this document.

All requirements described in this document are mandatory, must be implemented by leadership in their respective areas and are auditable.

It is essential to comply with the elements of Vale Production System (VPS), with attention to: Risk Perception and Management (4), Health, Safety and Environment (5), Change Management (9) and Emergency, Crisis and Business Continuity (12).

Questions and suggestions related to this document should be sent to the Health, Safety and Environment area via email to HSE.Corp <HSE.Corp@Vale.com>.

Compliance with legislation

Complying with the requirements in this document does not cover all requirements in local health and safety legislations. Therefore, full compliance with local health and safety legislation must be adopted as a basic premise.

In case of conflict between a requirement in this document and that of the local legislation, the one that is most stringent in health and safety must be applied.

Exception criteria

In absolute impossibility to comply with any requirement in this document or the need to replace this requirement with another practice, equipment or facility that is equivalent in risk reduction, the following must be adopted, under the sole responsibility of the requesting area:

a) Preparation of technical study including, as a minimum, the description of the activity, justifications for non-compliance or replacement, proposed control measures and documented risk analysis;

b) Formal approval from the area Director;

c) Communication and submission of the study to Vale's Health, Safety and Environment Department.

The HSE Department must review the Technical Study and approve or decline the exception for non-compliance or requirement substitution. Any cancellation of the non-compliance or replacement request must also be formally reported to the HSE Department.

Criteria for short-term occasional access

Short-term Occasional access where employees are expected to perform critical activities may be permitted without the need for applicable RAC training as per the procedure below:

a) Orientation with the site's general safety rules, including emergency procedures;

b) Preparation of a documented risk analysis, with the participation of those involved to discuss risk situations and control measures.

Where applicable, employees must have training records that demonstrate compliance with local legislation. This permission is not applicable for Vale employees.

General requirements

a) This document must be referenced and incorporated into procedures regarding local practices;

b) Safety equipment and devices must be designed, installed, manufactured and/or purchased as prescribed by legislation, technical standards and/or manufacturers specifications;

c) Modifications to equipment must be made upon approval by the manufacturer. When the manufacturer is not commercially or technically available, modifications must be made according to a formal project by a qualified professional. Modifications must follow the local management of change process;

d) The training required in the RACs must follow the Valer/HR Training Guidelines for the country concerned;

e) Training conducted in one site must be accepted in other sites;

f) It must be implemented a health assessment program in accordance with local legislation, for employees mapped to perform critical activities. The program must comply with local legislation and follow the standards of the "PGS-003523 Corporate Guideline for Occupational Health Management";

g) Every employee must exercise the right to refuse and not execute the activity if they find any non-compliance with the requirements of this document.

Roles and Responsibilities

a) Business units must:

I. Keep a list of requirements that the unit failed to comply with or replaced out of necessity, as per item "Exception criteria" of this document;

II. Keep a list and quantity of employees who perform critical activities under this document;

III. Manage an action plan for the implementation of new requirements under this document, considering the implementation deadline of these new requirements.

b) Local Health and Safety areas must:

I. Plan, coordinate, and monitor the implementation, maintenance and compliance with RACs;

II. Support contract managers and leaders in the procurement and contracting processes of goods and services related to the RACs;

III. Unfold the requirements of this document to management and supervisory level employees.

c) Management and Supervisory Level Employees:

I. Ensure implementation and compliance with RACs;

II. Ensure that all employees involved in performing critical activities are competent professionals.

d) Health, Safety and Environment department:

I. Provide technical assistance to Business Units in the implementation, compliance and monitoring of RACs;

II. Review the document and establish maximum deadlines for complying with the new critical activities requirements.

Notes about the revision

This document is valid from the date of its publication. The deadlines for implementing new requirements (**identified in bold font**) are defined in Annex V**.**

For requirements that have interim measures defined in Annex V, those measures must be complied with until the requirement is implemented.

RAC adherence

Data on compliance to RACs come from adherence protocols available in SAP – IM. Through these protocols, the areas must respond if the requirements are complied.

The area protocol must be updated once a year to compose the official adherence result.

It is strongly recommended, however, that the protocols are updated at least twice a year, once before the budget cycle and the other before the end of the year.

Only data registered through these protocols will be considered official and will appear in the global dashboard for adherence to RACs.

The premise for registering and applying the protocols can be read at: RAC Adherence: Premises | RAC Adherence: Premises (sharepoint.com).

Priority requirements

Priority requirements are those that:

a) Based on a technical study, they were highlighted as the cause or contributing factors for the occurrence of N1, N2 and N3;
b) Contribute significantly to reducing the level of risk, considering Vale's risk matrix, or act on various causes.

Compliance with all the requirements of this document is mandatory, but the priority requirements will have a different approach than the others, being prioritized for implementation and management:

a) They will be prioritized in the consultancy and field monitoring process by the HSE Department;
b) They must be prioritized in inspections of leaders and the Safety team;
c) They must be prioritized in the annual budget cycle.

Priority requirements are identified with the symbol 

throughout this document.

1. RAC 1 – WORKING AT HEIGHT

1.1 Foreword

A significant portion of fatalities and high-potential incidents at Vale included activities during works at height. The main contributing factors associated with these incidents were:

a) **Inadequate planning and/or changes during the execution of the activities;**
b) **Failure to comply with the measures provided in the hazard analysis;**
c) **Failure in the supervision of the activities;**
d) **In the closing / fixing of openings in floors and guardrails (open spaces);**
e) **Scaffolding erected in disagreement with the project;**
f) **Lack and/or inadequate use of the safety harness;**
g) **Carrying out the activities in an unsafe manner.**

1.2 Purpose

To establish requirements for working at heights in Vale's service, with the aim of eliminating, controlling and minimizing the risk of injuries or fatalities.

1.3 Application

Activities where there is a risk of people and objects falling from a different level equal to or greater than 1.80 meters from the lower level.

1.4 Exceptions

Activities where there is no risk of people and objects falling from a different level equal to or greater than 1.80 meters from the lower level. For these activities, additional measures must be adopted to avoid, eliminate and/or minimize the risks of incidents.

1.5 Important definitions

- **Attached basket**: bucket or platform attached to a crane vehicle to lift people to perform work at height, with or without electrical insulation, which may also lift support material essential for carrying out the service.
- **Aerial basket**: vehicular equipment to lift people to perform works at height, equipped with a movable, articulated, telescopic or mixed arm, with a bucket or a platform, with or without electrical insulation, which may, as long as it is designed for this purpose, also to lift materials by means of a winch and a complementary boom (JIB), complying with the manufacturer's specifications.
- **Suspended basket**: set formed by the suspension system and the bucket or platform lifted by the crane equipment.
- **Full body safety harness**: **Personal Protective Equipment consisting of a device attached to the body designed to retain and distribute the forces generated when a worker falls**.
- **Connection element**: **element with the function of connecting the full body harness to the anchor point.**
- **Collective fall protection element**: sections or parts of guardrails (top, intermediate rails and toe board), including trapdoor guardrails, floor plates and structural support elements that are typically part of the walkways, platforms and safety nets for works at height and elevated areas.
- **Anchor Point: point which is part of the anchor system where the Personal Protective Equipment (full body harness) for fall prevention is anchored by means of a connecting element.**
- **Workplace: specific place or space where the worker will perform his activities.**
- **Professional competent in working at heights: a professional legally qualified or qualified in occupational safety to carry out the measures provided for in item 1.9.4.**
- **Fall protection: methods to reduce the possibility of people falling.**

- **Anchor system: set of components that make up a personal fall protection system incorporating one or more anchor points, designed to withstand the applicable forces.**
- **Fall protection system:** system designed to eliminate the risk of workers falling or to minimize the consequences of falling in activities carried out above 1.80 m.
- **Collective Fall Protection System: systems designed to eliminate/control the fall risk, such as guardrails, safety nets and other collective protection elements against falls.**
- **Individual Fall Protection System**: **systems designed to minimize the consequences of a fall, consisting of an anchor system, a connection element, and the Personal Protective Equipment (body harness).**
- **Movement restriction system**: system capable of restricting the movement of a person in a work surface and to avoid that he/she reaches a spot from which he/she can fall.
- **Fall retention system: individual fall protection system that does not prevent the fall, but stops it once it has started, minimizing its consequences.**
- **Work positioning system**: work system designed to allow the worker to remain positioned in the workplace, fully or partially suspended, without the use of hands.
- **Lanyard: connecting element of a personal fall protection system, adjustable or not, to support, position and/or limit the movement of the worker.**
- **Sliding fall arrester**: **connection element that moves along an anchor line accompanying the worker with no manual intervention, during changes in positioning, up and down, and which automatically locks on the anchor line when a fall occurs.**
- **Self-Retractable fall arrest**: **connection element equipped with a certified spring winding line which automatically adjusts its length under moderate tension and, under high tension, locks to prevent further movement or falling.**

1.6 Requirements for installations and equipment

1.6.1 General requirements to prevent fall of objects, materials, and tools:

a) Isolation and warning must be done with physical barriers, such as barrier mesh and,–**cones and**–**markers, among others**. For short-term activities, after the risk analysis performed by the area, other types of isolation and signs-such as nylon tape, ropes or chains may be used. The use of plain plastic tape is prohibited to isolate the area;
b) Tool tie up system;
c) Toe board with minimum height according to technical standards, at the bottom of people lifting equipment, scaffolds, platform ladders and locations where there is a risk of falling objects;
d) Safety nets, where area isolation is not feasible, due to the nature of the activity and the presence of people involved in the work at a lower level is required.

1.6.2 General requirements to prevent fall of people:

a) Guardrail, in people lifting equipment, scaffolds, platform ladders, excavations and, when applicable, in locations where there is a risk of falling of people, designed in accordance with technical standards, containing:
   I. Upper rails.
   II. Mid-section rails.

b) Use of an individual fall protection system where requirement 1.6.2.a cannot be complied with or where it does not offer full protection against falling risks.

c) Use of lifeline fixed to an independent structure in the following situations:
   I. Rope access Aactivities;
   II. Suspended scaffolds;
   III. Suspended chairs;
   IV. Locations where there is the risk of falls due to a surface collapse.

1.6.3 General requirements for the scaffold:

Scaffolds must:

a) Be metallic[1], designed and dimensioned under the responsibility of the legally qualified professional (or equivalent, according to local legislation);
b) Be of tubular, platform, with protection in the clamps in access and work areas;
c) Have the trapdoor with physical barriers installed around it, to prevent people from falling;
d) Be assembled from projects that contemplate, among others, the necessary access for evasion of users during emergency scenarios.

1.6.4 Variable requirements according to scaffold:

Specific Requirements	Fixed supported scaffold	Mobile supported scaffold	Suspended scaffold
(a) Access ladder incorporated to the structure.	X	X	
(b) Shoes in solid / resistant bases.	X		
(c) Locking of casters.		X	
(d) Automatic mechanical locking device, meeting the maximum load capacity of the equipment.			X
(e) Independent lifeline.			X
(f) Visible plate with maximum allowable workload.	X	X	X

1.6.5 General requirements for the ladders:

a) Any type of ladders must be dimensioned, including intermediate levels, according to **technical standards and/or manufacturers' recommendations.**
b) For access on fixed **vertical**-ladders-(sailor) above 1.80 meters, it is mandatory to use **personal fall protection systems connected to one of the following**:
I. **Vertical** lifeline **with sliding fall arrest**.
II. **Anchor point with** retractable fall arrest **installed by means of a anchoring stick or other devices.**
III. **Anchor point directly to the structure using the ladder rung** and double lanyard as a **connecting element**.
IV. Safety cages, properly installed, in locations where local legislation accepts that safety cages act as protection against falls on fixed vertical ladders.
c) The anchor points mentioned in the above requirements must comply with requirement 1.7.4.

1.6.6 Variable requirements according to ladder[2] type:

Specific Requirements	Simple ladder	Double dadder (opened)	Extendable ladder	Fixed cage ladder
(a) Steps and platforms whit material non-slip surface.	X	X	X	X
(b) Non-slips shoes.	X	X	X	X
(c) Specific maximum length.	X	X	X	
(d) Stabilization devices / Locking of casters.				X

1.6.7 General requirements for equipment for lifting people:

a) Anchor point for the **individual fall protection system**;

[1] Chek the requirement 10.7.1 (u) of RAC 10 for assembling and disassembling conductive material scaffolds in electrical work.
[2] Check and follow the requirement of RAC 10, 10.7.1 (t) for the use of metallic ladders in electrical work.

b) Movement control of the platform or basket on the ground console;
c) Emergency stop device on the ground console.

1.6.8 Variable requirements according to the type of equipment for lifting people:

Specific Requirements	Aerial Work Platform	Lifting Equipment to hoist people		
		Man Basket	Coupled Man Basket	Suspended Man Basket
(a) Stabilizer system with inclination indicator.	X	X	X	X
(b) Wheel lock / braking system.	X	X [3]		
(c) Emergency system allowing arm movement and tower rotation in case of failure.	X	X	X	
(d) System that allows basket leveling and prevents inclination.	X	X	X	
(e) Visual and audible signaling during the vertical movement of the equipment.	X			
(f) System that prevents stabilizer shoes from operating without the previous retraction of the mobile arm.		X	X	
(g) Anemometer.	X			X
(h) Boom radius and angle indicators with visual and audible alert.				X
(i) Block lift height indicator that stops lifting when reaching set height.				X
(j) Physical or electronic device or proximity sensor that prevents the risk of crushing the operator of the equipment against another structure.	X [4]			

1.7 Requirements for procedures

1.7.1 General requirements for procedures:

a) Before any activity that involves working at heights, in the planning stage, one must analyze and define which individual and/or collective fall protection system will be adopted;
b) The **individual fall protection systems** must have initial, pre-use and periodic inspections **observing the recommendations of the manufacturer and/or legally qualified professional (project designer)**;
c) The connection elements must be fixed to an **anchor point** during the activity that presents falling risks, according to a hazard analysis;
d) The use of abdominal body harnesses (miners' belt) is prohibited. The abdominal component of the harness should be used only for work positioning and movement restraint;
e) All the activities involving works at height must have a procedure and/or a hazard analysis and must be performed under supervision defined according to the hazard analysis in accordance with local technical standards;
f) The hazard analysis of activities involving works at height must consider the free fall zone or the minimum space required under your feet of the individual fall protection system so that in case of a fall the worker does not collide with the lower level or structure.

[3] When no using outriggers.
[4] **Not applicable to AWP Scissor type.**

1.7.2 Requirements for scaffolds:

a) **Units, through the engineering sector, must provide information so that scaffold structure designs that may be assembled (supported) on process equipment meet the mechanical strength limits of such equipment in order to avoid collapses thereof, their structures and devices;**
b) Scaffolds must be constructed on a flat surface free of damage or deformation;
c) The trapdoor and the barrier around the scaffolds must always be closed;
d) Scaffolds must be formally released for use after:
   I. The verification of compliance with the project;
   II. Issuing a formal release document;
   III. Indication of release for use with the plate released/not released.
e) It is prohibited to move mobile scaffolds with **people**, equipment, tools, or objects;
f) Units must assign representatives (or designated) duly **trained** to verify and ensure the assembling and **disassembling** of the scaffolds in accordance with the premises of the respective projects, including the verification of assembly modifications, duly documented by the assembly service providers, based on technical criteria established by the specialized assembly company;
g) The use of personal fall protection systems may be exempted for employees who perform activities on safe scaffolding used as a workplace, provided that all the requirements listed in annex I are attended.

1.7.3 Equipment for lifting people:

a) Suspended baskets may only be used rescue and emergency situations;
b) Stabilization during the use of the attached and suspended baskets must be done with the complete opening of the stabilizer arms;
c) To exit or enter the basket of the aerial work platform when it is lifted, the worker must have the connection element **connected** to a designed anchor **system** supported by a hazard analysis.

1.7.4 Requirements for anchor systems:

a) The anchor system must be resistant to the submitted effort;
b) The project of the anchor point must be done by an assigned professional legally certified;
c) The structure integrating an anchoring system must be capable of resisting the maximum applicable force;
d) The anchor system must be selected so that the impact force transmitted to the worker is a maximum of 6 kN in the event of a fall or comply with the local legislation;
e) The anchor system must comply with the applicable technical standards;
f) The anchor system must be installed by a qualified professional (under the responsibility of a legally certified professional;
g) The periodic inspection of the Vale's and service providers fixed anchor system must take place at an interval not superior to 12 months;
h) Vale's and service providers fixed anchor system inspections must be registered in a computerized system where it is possible to track the systems.

1.7.5 Requirements for rescue at height:

a) The Emergency Response Plan must contain existing work at height scenarios and the professionals must be **qualified** and prepared, in addition to considerations of the appropriate equipment to carry out rescues at height;
b) Rescue conditions involving inert suspension must be simulated and actions taken to reduce the suspension trauma scenario.

1.7.6 Requirements for rope access:

a) Rope access must be performed according to **technical** standards whenever all the following conditions are verified:
   I. The slope of the work surface does not enable the worker to perform his activities without the risk of falling;
   II. The activity needs rope for the worker to position himself over the work structure;
   III. The **worker** needs a rope to move vertically or horizontally to reach a given **place** of the work structure.

1.7.7 Requirement for removing floors, gratings, guardrails, trapdoors and other elements of collective fall protection:

a) Openings with the risk of falling must be previewed in the plan and approved by the area owner with the issue of a Safe Work Permit (SWP) and must have a Hazard Analysis for the activity;
b) Before the start of the activity, the opening location must be adequately isolated with a physical, rigid, and fixed barrier to prevent unauthorized access and be clearly signaled informing the risks of the location;
c) Every worker exposed to the risk of falling through the opening must be anchored in an **anchor system**, according to requirement 1.7.4;
d) The removal must be carried out by persons trained and authorized to work at height (RAC 01 and local standards) and applicable procedures;
e) The opening resulting from the removal of a floor, guardrail or hatch cover must be completely isolated with a physical, rigid, and fixed barrier to prevent unauthorized access and be clearly signaled informing the risks of the place;
f) At the end of the activity, the opening must be closed immediately, and the location must be fixed making sure that the installation is in safe conditions for use;
g) Hatches must be inventoried, and their use controlled by locks;
h) Collective fall protection elements must be periodically inspected considering, as a minimum, the requirements of PGS 004728 – Floor Gratings, Openings and Trap Doors.

1.8 Requirements for training

1.8.1. General requirements for training

a) Workers who perform activities at height, considering the applicability criteria of this RAC, must be trained in:
   I. RAC 01, including retraining, according to Valer training guidelines;
   II. Training for works at height as required by local law.

b) Employees operating aerial work platforms and personnel lifting equipment must be **trained** in the safe operation of such equipment;

c) Scaffold inspectors must be trained to verify and ensure the scaffold assembling and disassembling execution, including the verification of modifications.

1.9 Roles and responsibilities

1.9.1 Owner of the area and Contract Manager:

a) Ensure all RAC requirements are complied with in their areas;
b) Follow the safety performance and compliance to the supplier requirements involving works at height;
c) Participate in all investigations related to incidents involving works at height.

1.9.2 Planner and Scheduler:

a) Know the RAC requirements applicable to their areas of activity and ensure that hazard analysis for works at height are initiated on its respective work processes.

1.9.3 Tool Shop Supervisor and/or Resources (Materials) Responsible (professionals in charge to manage the work at height equipment and devices)

a) Ensure that all devices for work at height are inspected when received, as well as periodically;
b) Set the inspection plan including the frequency according to the respective standards;
c) Segregate and send for disposal all equipment and devices in nonconformance condition.

1.9.4 Competent professional in working at height

a) Provide support for the hazard analysis of the activities involving work at heigh;
b) Establish the management system for equipment and components for works at height;

c) Have work at height scenarios and activities mapped and updated.
d) Provide technical support and implement the guidelines established in this standard.

1.9.5 Scaffold Inspector:

a) Verify and ensure that scaffold assembling complies to the premisses of the related projects, including the verification of changes in the assembling duly documented by the service providers.

1.9.6 Professional certified in anchoring systems

a) Design anchoring systems and their fasteners.

1.9.7 Workers carrying out activities at height:

a) Only carry out activities at height if they are trained and authorized;

b) Fully comply with the guidelines set out in this standard and in the applicable technical requirements;

c) Refuse to work in unsafe conditions and/or with a serious and imminent risk of incidents.

2. RAC 02 – LIGHT MOTOR VEHICLES

2.1 Foreword

High-potential incidents involving light motor vehicles occurred at Vale, and the main contributing factors to these events were:

a) Speed incompatible with road conditions;
b) Poor road conditions;
c) Lack and/or failure of preventive maintenance;
d) Poor visibility;
e) Driver fatigue and/or drowsiness;
f) Lack and/or failure to comply with the Traffic Plan;
g) Other driver risky behavior.

2.2 Purpose

To establish requirements for the safe driving of motor vehicles at Vale's service, with the aim of eliminating, controlling, and minimizing the risks of fatalities, injuries, or incidents.

2.3 Application

The requirements of this RAC apply to the driving of light vehicles owned, leased, or rented at Vale´s service in addition to vehicles from service providers subject to a contract with Vale, on public roads or roads owned by Vale, including underground and surface mine areas.

Types of light motor vehicles covered in this document: cars, sports utility vehicles, pick-up trucks, minivans, full size vans, minibuses and buses ((both compact and full size).

2.4 Exceptions

These requirements do not apply to:

a) Vehicles which are not at service of Vale, driven by people who have permission to access the Sites of Vale [5];
b) Vehicles for emergency response[6].

2.5 Important definitions

- **Primary Auxiliary Braking System (engine brake):** mechanical property of the vehicle which reduces or maintains the speed of the vehicle when the driver takes the foot off the accelerator pedal while the vehicle's engine is in low gear on a descent.
- **Dedicated Vehicles:** vehicles of continuous use owned or rented for more than three months.
- **Drowsiness Detection System:** devices that use different Technologies to determine whether a person is beginning to feel fatigue and/or to fall asleep while operating a motor vehicle or a mobile equipment.
- **Level Crossing: crossing of the railway at the same horizontal plan of the road.**
- **Mine Area:** areas used for mining activity, such as open pits, underground mines, permanent travel routes, shift change areas, lookouts, maintenance workshop, where the access of vehicles, equipment and people is controlled
- **Mining Operations:** areas where the following activities occur including drilling and blasting, mining, material loading and unloading and dumping of waste rock**.**

[5] The specifications of these vehicles must comply with local legislation and drivers must obey the site traffic rules.
[6] Light motor vehicles owned by Vale or in service of Vale do not need to use reverse audible alarm on public roads, administrative areas or close to Vale's neighboring communities.

- **Operational Area:** all internal areas of Vale's Sites (terminals, power plants, railways, mine areas, internal parking areas, among others), where the access of motor vehicles, mobile equipment and people is controlled.
- **Operational Road:** roads, access roads and traffic routes in the operational area.
- **Over-the-counter Rental Vehicle**: vehicle for temporary use rented directly from accredited car rental companies at airports or in agencies, which contract must not last longer than 3 consecutive months, regardless of whether it is a single contract or more than a contract.
- **Pre-use Inspection: formal checklist to inspect tires, headlights, and general conditions of the vehicle each time there is a change in the vehicle driver (conductor).**
- **Proximity Alert System among Equipment:** system installed on mobile equipment, motor vehicles and/or people, which allows their georeferencing and triggers an alert if they are within a defined proximity limit**.**
- **Secondary auxiliary braking system (hydraulic retarder):** auxiliary braking system that works independently of, and in conjunction with the engine and the service brakes.
- **Telemetry:** wireless data transmission and reception technology that aims to remotely monitor mobile equipment and motor vehicles.

2.6 Requirements for installations and equipment

2.6.1 Requirements for the operational roads and circulation of light motor vehicles:

a) All the operational roads must be part of the Traffic Plan;

b) Physical barriers or protective devices (such as aerial walkways, bumps, gates or lights activated by pedestrians on safe walking paths, routes, accesses, among others) must be installed to segregate the interfaces between people and motor vehicles as much as possible, where there is a significant risk of contact among vehicles and people; P!

c) Permitted speed road signs must be installed in the internal roads;

d) Parking areas must be designated for parking light motor vehicles. These areas must allow a safe separation from mobile equipment;

e) Traffic routes for the circulation of mobile equipment, vehicles and pedestrians must be clearly identified;

f) The mining areas must be leveled;

g) In underground mining, there must be cutouts for the parking of light motor vehicles in a way that does not interfere with the traffic in the main roads.

2.6.2 General requirements for light motor vehicles:

a) It is prohibited to use motorcycles, bicycles, tricycles, quadricycles, among others, at Vale's service and/or inside Vale property;

b) All vehicles must receive the required preventive maintenance as recommended by the manufacturer; P!

c) Modifications in light vehicles must only be done with the formal approval of the manufacturer.

2.6.3 Specific Requirements for light motor vehicles on public roads:

Specific Requirements[7]	Dedicated Vehicles	Rental Vehicles	Vans	Micro buses	Buses
a) Three-point seat belts for all passengers	X	X			
b) Three-point seat belts for front seats and two point for other seats			X	X	X

[7] It is recommended that, where vehicles manufactured with Roll Over Protection Systems (ROPS) are available, this option be adopted as another protective barrier for the vehicle's passengers.

c)	Headrests for all passengers	X	X	X	X	X
d)	Airbag for the driver and the front seat passenger	X	X	X		
e)	Anti-lock braking system (ABS)	X	X	X		
f)	Vehicle warning signaling devices (reflective triangles)	X	X	X	X	X
g)	Audible Reverse Alarm[8]	X		X	X	X
h)	Reverse Sensor or vehicle backup camera	X		X	X	X
i)	Location and speed monitoring system (telemetry)	X		X	X	X
j)	Driver drowsiness detection system	X[9]		X	X	X
k)	Primary Auxiliary Braking System (engine brake)				X	X
l)	Secondary auxiliary braking system (hydraulic retarder)					X[10]
m)	Emergency exits with easy-to-use opening mechanism				X	X

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2.6.4 Specific Requirements for light motor vehicles in operational areas:

Specific Requirements[11]	Dedicated Vehicles	Vans	Micro buses	Buses
a) Three-point seat belts for all passengers	X			
b) Three-point seat belts for front seats and two-point seat belts for other seats		X	X	X
c) Headrest for all passengers	X	X	X	X
d) Airbag for the driver and the front seat passenger	X	X		
e) Anti-lock braking system (ABS)	X	X		
f) Vehicle warning signaling devices (reflective triangles and cones)	X	X	X	X
g) Audible Reverse Alarm[12]	X	X	X	X
h) Reverse Sensor or vehicle backup camera	X	X	X	X
i) Location and speed monitoring system (telemetry)	X	X	X	X
j) Driver drowsiness detection system	X[13]	X	X	X
k) Primary Auxiliary Braking System (engine brake)			X	X
l) Secondary auxiliary braking system (hydraulic retarder)				X[14]
m) Emergency exits with easy-to-use opening mechanism			X	X

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2.6.5 Specific Requirements for light motor vehicles that access the mining area:

Specific Requirements[15]	Dedicated Vehicles	Micro buses
a) Three-point seat belts for all passengers	X	

[8] Light motor vehicles owned by Vale or in service of Vale do not need to use reverse audible alarm on public roads, administrative areas or close to Vale's neighboring communities.

[9] See requirement 2.7.c.v. below.

[10] Mandatory for 6x2 or 8x2 buses mounted with rear engines and with legal total gross weight > 19,5 tons used in mountain regions (mountainous areas

[11] It is recommended that, where vehicles manufactured with Roll Over Protection Systems (ROPS) are available, this option be adopted as another protective barrier for the vehicle's passengers.

[12] Light motor vehicles owned by Vale or in service of Vale do not need to use reverse audible alarm on public roads, administrative areas or close to Vale's neighboring communities.

[13] See requirement 2.7.c.v. below.

[14] Mandatory for 6x2 or 8x2 buses mounted with rear engines and with legal total gross weight > 19,5 tons used in mountain regions (mountainous areas

[15] It is recommended that, where vehicles manufactured with Roll Over Protection Systems (ROPS) are available, this option be adopted as another protective barrier for the vehicle's passengers.

b) Three-point seat belts for front seats and two-point seat belts for other seats		X
c) Headrests for all passengers	X	X
d) Airbag for the driver and the front seat passenger	X	
e) Anti-lock braking system (ABS)	X	
f) Vehicle warning signaling devices (reflective triangles and cones)	X	X
g) Audible Reverse Alarm	X	X
h) Reverse Sensor or vehicle backup camera	X	X
i) Location and speed monitoring system (telemetry)	X	X
j) Driver drowsiness detection system	X[16]	X
k) Electronic Braking Control (EBD)	X	
l) Stability control	X	
m) 4x4 Traction	X	
n) Traction control system	X	
o) Reflective striping	X	X
p) Communication system between vehicles and mobile equipment (two-way radio)	X	X
q) Visible pennant with LED light at the tip, installed according to the height of the highest equipment circulating in the mine	X	X
r) Roof Mounted flashing, rotating or strobe light	X	X
s) Proximity alert system among equipment	X	X
t) Primary Auxiliary Braking System (engine brake)		X
u) Emergency exits with easy-to-use opening mechanism		X

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2.6.6 Specific Requirements for Utility Terrain Vehicles[17] (UTV) and Snowmobiles:

Specific Requirements	Utility Terrain Vehicles (UTV)	Snowmobiles
a) Rollover Protection Structures (ROPs)	X	
b) Three-point seat belts	X	
c) Reflective striping	X	X
d) Roof Mounted flashing, rotating or strobe light	X	
e) Fire extinguishers	X	X
f) Laminated windshields with wipers	X	
g) Helmets	X	X

2.7 Requirements for procedures

a) All persons who drive vehicles at Vale's service, inside or outside Vale installations, must:

I. Comply with the Site traffic plan;

II. Do not drive under the influence of alcohol and drugs;

III. Permit only the number of passengers compatible with the number of 3-point seat belts and headrests available;

IV. Only start driving the vehicle when all passengers are using the seat belts;

[16] See requirement 2.7.c.v. below.

[17] The use of Utility Terrain Vehicles and Snowmobiles is permitted exclusively where access with conventional light vehicles is impossible, due to the specific characteristics of the location and/or legal environmental restrictions for opening access roads.

V. Respect the speed limits established by the road signs;

VI. Always have the headlights turned on while the vehicle is in movement;

VII. While the vehicle is not parked at a safe place, do not use TV / DVD, headset sound and mobile phone;

VIII. Apply the parking brake, turn off the engine and remove the ignition key before leaving the vehicle, except for the pre-use inspection;

IX. Chock the wheels of vans, minibuses, or buses after parking the vehicles;

X. For vehicles in surface mining areas, have a high visibility flag installed on top of the vehicle antenna, keep the two-way communication radio always turned on for interaction with other vehicles and equipment, and keep roof mounted flashing, rotating or strobe light always turned on;

XI. Only transport loads in vehicles suitable for this, considering the type and size of the load to be transported and using a compatible mooring and packaging system;

XII. In vehicles, luggage must be packed or affixed to ensure the safety of occupants;

XIII. The drivers of the road vehicles must respect existing rules for crossing the level, such as:

- **Stop outside the level in a place which allows a wide view of both sides of the railway track;**
- **Roll down the windows, turn off the vehicle radio and look in both directions;**
- **Obey local signs and train passing alerts (horns);**
- **Before crossing the railway, check if the other side of the highway is cleared and that there is no risk of stopping on the level passage;**
- **It is prohibited to stop or maneuver a road vehicle on a passage level.**

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b) All Vale Sites must have an Internal Traffic Plan that includes the basic elements described in Annex II;

c) The operational areas where light motor vehicles circulate must manage, in synergy with the Internal Traffic plan, the following requirements:

I. Formal initial mobilization inspection of the vehicle;

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II. **Pre-use** inspection;

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III. Fatigue Plan, as per **PNR-000257** – Guidelines for Fatigue Prevention Programs;

IV. Telemetry management system, including:

- System for periodic and routine verification of the information available;
- Consequence Policy in case of violations.

V. Management of drowsiness detection systems, including:

- System for periodic and routine verification of the information obtained;
- Actions to be taken in case of deviation**.**

2.8 Requirements for training

All persons who drive vehicles at Vale´s service must:

a) Be trained in RAC 02 according to the Valer guidelines;

b) Have training in local procedures within the validity period;

c) Have a valid driving license specific for the type of motor vehicle, according to local legislation.

2.9 Roles and responsibilities

2.9.1 Leader of each location / site (supervisor, manager, or director):

a) Implement the Site Traffic plan;

b) Implement the requirements for light motor vehicles;

c) Implement the specific procedures previewed in this RAC;

d) Approve modifications or inclusions of safety accessories in the light motor vehicles.

2.9.2 Leader of each operation / project (supervisor, manager, or director):

a) Document the inventory of light motor vehicles at Vale´s service in the location, for Vale and contractor employees;

b) Document the list of people authorized by their immediate superiors and trained, containing the following information:

I. Training dates;

II. Date of next refresher training;

III. Number and validity of the driver's license, including for employees who drive over-the-counter rental vehicles.

3. RAC 03 – MOBILE EQUIPMENT OPERATION

3.1 Foreword

High potential incidents involving mobile equipment occurred at Vale, and the main contributing factors to these events were:

a) Lack or absence of berm protection;
b) Operator fatigue and/or drowsiness;
c) Lack or deficiency in the preventive maintenance;
d) Lack or deficiency of segregation among people, vehicles and mobile equipment;
e) Speed incompatible with the road conditions;
f) Poor road conditions or ground instability;
g) Poor visibility;
h) Lack or deficiency in the traffic plan;
i) Proximity to aerial and underground obstacles;
j) Lack and/or failure to specify equipment;
k) Lack or deficiency in the specific procedures;
l) Lack or deficiency in training on the specific type of equipment;
m) Other risky operator behaviors.

3.2 Purpose

Establish requirements for the safe operation of mobile equipment at Vale's service, to eliminate, control and minimize the risks of fatalities, injuries, or incidents.

3.3 Application

Operation of Vale's owned, leased or rented surface and underground mining mobile equipment, as well as equipment of service providers that are subject to the scope of Vale's contract and that circulate on public roads, operational areas, mining areas and operational roads.

3.4 Exceptions

The requirements of this RAC do not apply to:

a) Light motor vehicles covered by RAC 02;
b) Equipment moving exclusively on railway tracks;
c) Ship loaders;
d) Overhead cranes;
e) Monorails;
f) Aerial work platforms or load lifting equipment covered by the requirements of RACs 1 and 5, respectively;
g) Stacker reclaimers and mobile stacker;
h) Equipment for transporting dangerous products;

i) Equipment for emergency[18] response;

j) Equipment used for warehouse cleaning (mini sweepers) and grass cutting (mini lawn mowers);

k) Retractable electric pallet trucks and forklifts which must follow the manufacturer's recommendations.

3.5 Important definitions

- **Anti-collision system with automatic braking of equipment:** system installed on mobile equipment, motor vehicles and/or people, for their georeferencing, and that acts automatically on the braking system of equipment and vehicles when there is the risk of an imminent collision.
- **Drowsiness Detection System:** devices that use different Technologies to determine whether a person is beginning to feel fatigue and/or to fall asleep while operating a motor vehicle or a mobile equipment.
- **Large Mobile Equipment:** equipment with a tare of 45 tons or more.
- **Level Crossing: crossing of the railway at the same horizontal plan of the road.**
- **Mine Area:** areas used for mining activity, such as open pits, underground mines, permanent travel routes, shift change areas, lookouts, maintenance workshop, where the access of vehicles, equipment and people is controlled.
- **Mining Operations:** areas where the following activities occur including drilling and blasting, mining, material loading and unloading and dumping of waste rock**.**
- **Mobile Equipment**: motor-driven equipment used to move, transport, excavate, displace, or shove materials.
- **Mobile Equipment without cabin:** equipment with no protective structure to shield the physical integrity of the operator.
- **Mobile Surface Mining Equipment:** motor graders, scrapers, backhoes, excavators, tractors, forklifts, tire handlers, dump trucks, other trucks, drilling rigs, skid steer loaders, among others.
- **Mobile Underground Mining Equipment:** loader, lorry, transporter, roof hoisting and throwing equipment, motor grader, backhoe, drilling rig, scalers, rigs, among others.
- **Operational Area:** all internal areas of Vale's Sites (Terminals, Power Plants, Railways, Mining Areas, internal parking Areas, among others), where the access of motor vehicles, mobile equipment and people is controlled.
- **Operational Road:** roads, access roads and traffic routes in the operational area.
- **Other Trucks**: road trucks, tipper trucks, track trucks, articulated trucks, tank trucks, road train trucks, flatbed trailer trucks and **crane trucks**. The latter must also meet the requirements of RAC-05 - Load Lifting.
- **Pre-use Inspection**: formal checklist to inspect the general safe conditions of the mobile equipment before use.
- **Primary Auxiliary Braking System (engine brake):** mechanical property of the vehicle which reduces or maintains the speed of the vehicle when the driver takes the foot off the accelerator pedal while the vehicle's engine is in low gear on a descent.
- **Proximity Alert System among Equipment:** system installed on mobile equipment, motor vehicles and/or people, which allows their georeferencing and triggers an alert if they are within a defined proximity limit.
- **Restricted Areas:** operational areas where the access of people, vehicles and equipment must be restricted and controlled, primarily to reduce the number of people exposed and the potential of accidents.
- **Safety distance:** minimum distance from the equipment or vehicle in front, which allows the driver or operator to stop the vehicle or equipment without causing a collision in the event of braking or sudden stopping of the vehicle in front.

[18] Emergency response vehicles must comply with local legislation and site procedures.

- **Secondary auxiliary braking system (hydraulic retarder):** auxiliary braking system that works independently of, and in conjunction with the engine and the service brakes.
- **Synchronized gearbox:** mechanical device installed in the gearbox with the purpose of equalizing the speeds of the toothed elements before engaging other gears, allowing smooth changes without jerks and without the need to stop the equipment.
- **Telemetry:** wireless data transmission and reception technology that aims to remotely monitor mobile equipment and motor vehicles.

3.6 Requirements for installations and equipment

3.6.1 General Requirements for mobile equipment operational roads:

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a) Berm protection must be built with a minimum height corresponding to half the diameter of the largest tire among equipment that travel on the surface mining areas:
   I. On all operational roads;
   II. Along excavations;
   III. In areas where there is a risk of equipment falling or tipping over/overturning;
   IV. Around the equipment, during parking in mining areas (except workshops) for maintenance or interference;
   V. Around electrical equipment such as panels, transformers and electric poles;
   VI. On the exposed sides of pipelines located at ground level or suspended (pipe racks), near the operating routes.

b) In underground mining areas, where it is not possible to build berm protection, other types of physical barriers must be adopted to isolate the area;

c) All electrical lines, pipelines and structures in mine areas must be properly signaled;

d) Safety barriers (such as beams, limiters, height sensors) must be installed for the operation of mobile equipment in the vicinity of air and underground obstacles;

e) In operational areas and mining areas, where there is a significant risk of contact among equipment and people, the following must be done:

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   I. Install physical barriers or protective devices (such as aerial walkways, bumps, gates, or lights activated by pedestrians on safe paths, roads, accesses, etc.) that separate as much as possible the interfaces among people and mobile equipment;
   II. Provide two-way communication radios if there are road observers or spotters;

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   III. Post signs and barricade the area during the material handling, considering the operating range of the equipment and their implements.

3.6.2 Requirements for all mobile equipment:

a) Trucks must have synchronized gearboxes;

b) Mobile equipment with pivot points where there is a risk of crushing or pinching must have that hazard clearly and visibly signaled;

c) Mobile equipment with outrigger floats (stabilizer systems) must be hydraulically actuated;

d) The access ramps of the board trailers must have an electro-hydraulic system to move the access ramps;

e) Mobile equipment must have maximum load and tare signaling;

f) Mobile equipment must have external identification signs that allow remote visualization;

g) The use of manned mobile equipment with no cabin is not permitted;

h) All mobile equipment must have front windshields, which can be laminated or tempered with safety film or polycarbonate;

i) For night operations and/or in low visibility conditions, and whenever the standard lighting of the equipment is not efficient, auxiliary lighting approved by the manufacturer or the by Vale´s Engineering area must be used;

j) Mobile equipment owned by Vale or at Vale's service must have an audible reverse gear alarm which does not need to be used on public roads or close to Vale's neighboring communities;

k) Loads carried on trucks, which may move, displace, or tip over, must be tied, secured, or contained, except for bulk ore loads, which must be evenly distributed;

l) All mobile equipment must receive the preventive maintenance recommended by the manufacturer; P!

m) Modifications to mobile equipment must only be performed after the formal approval by the manufacturer;

n) The operation of manned amphibious excavator is prohibited.

3.6.3 Specific requirements according to mobile equipment:

Specific Requirements	Graders	Scrapers	Wheel Loaders	Backhoes	Excavators	Tractors	Forklifts	Tire Handlers	Drills	Haul trucks	Other Trucks
a) 3-point seat belt.										X[a]	X
b) 2- point seat belt.	X	X	X	X	X	X	X	X	X		
c) Rollover Protection Structure (ROPS).	X	X	X	X	X[b]	X				X	
d) Falling Object Protection Structure (FOPS).	X	X	X	X	X[b]	X				X	
e) Falling Object Guard (FOG)			X[c]	X[c]		X[c]					
f) Escape and landing alternatives in emergency situations.	X	X	X	X	X	X				X	
g) Proximity alert system among equipment. P!	X[e]	X[e]	X[e]	X[e]						X	X[e]
h) Anti-collision system with automatic equipment braking.										X	
i) Front video cameras.										X	
j) Rear video cameras.			X[d]		X[d]	X[d]			X[d]	X[d]	
k) Side video câmeras.					X[d]	X[d]			X[d]	X[d]	
l) Air-conditioned cabin.	X	X	X	X	X	X		X	X	X	X
m) Two-way communication radio.	X	X	X	X	X	X	X	X	X	X	X[e]
n) Location and speed monitoring systems (telemetry)										X	X
o) Load monitoring systems.										X	
p) Tire pressure and temperature monitoring systems. P!			X[d]							X	
q) Traction on at least two axes when there are 3 or more axes.											X[e]
r) Reflective stickers on the sides and rear.							X	X			X
s) Reverse warning light.	X		X			X[f]	X	X		X	X
t) Speed limiting device.							X	X		X	
u) Operator presence detection system.							X	X			
v) Fixed load table next to the commands.							X	X			
w) Primary auxiliary braking system (engine brake) and secondary auxiliary braking system (hydraulic retarder)											X[g]
x) Head rest.											X
y) Tilt position indicator (visual or audible on panel).										X	X[h]
z) Travel speed limiting device in raised tilt condition.											X[h]
aa) Inclinometer											X[h]

bb)	Signaling devices (reflective triangles, cones, plastic drums or stanchions).											X
cc)	Operator drowsiness detection system.										X	X(e)
dd)	Hydraulic actuation of fork opening and closing							X				

(a) Mandatory for the operator.
(b) Mandatory for 6 to 50 tons excavators.
(c) Mandatory for mobile equipment used in vegetable clearance and demolition.
(d) Required for large equipment.
(e) Required for mining operations only.
(f) Required for tire tractors.
(g)Mandatory for trucks with technical total gross weight equal or > 30 tons used in mountain regions.
(h) Mandatory for road dump trucks which have internal mechanisms for driving and lifting implements (buckets, boards, vacuum, among others).

3.6.4 General requirements for underground mining equipment:

a) Seat belt;
b) Falling Object Protection Structure (FOPS);
c) Roll Over Protection Structure (ROPS);
d) Auxiliary lighting, approved by the manufacturer or by Vale´s Engineering area, in addition to standard equipment lighting;
e) Audible reverse alarm;
f) Reverse warning light;
g) Escape and landing alternatives from the equipment in case of emergencies;
h) Two-way communication radio;
i) Traction in at least 02 (two) axes;
j) Safe braking system (service, parking, and emergency brakes) independent of equipment engine operation.

3.6.5 Specific requirements according to mobile underground mining equipment:

Specific Requirements		Graders	Wheel Loaders	Low Profile Loaders	Excavators	Underground Drills	Scalers	Telescopic Handlers	Rigs	Articulated Trucks (haul trucks)	Scissors lift trucks	Other trucks
a)	Falling Object Guard (FOG)				X							
b)	Front video cameras.			X								
c)	Rear video cameras.		X	X						X		
d)	Air-conditioned cabin.	X	X	X	X		X	X		X	X	X
e)	Location and speed monitoring systems (telemetry).									X	X	X
f)	Reflective stickers on the sides and rear.	X			X	X	X	X	X	X	X	X
g)	Speed limiting device.									X		
h)	Fixed load table next to the commands.		X	X	X							
i)	Primary auxiliary braking system (engine brake) and secondary auxiliary braking system (hydraulic retarder)									X(a)		X(a)
j)	Head rest.	X					X			X	X	X
k)	Signaling devices (reflective triangles, cones, plastic drums, or stanchions).											X
l)	Operator drowsiness detection system.									X	X	X

(a) mandatory for trucks with a technical total gross weight equal or > 30 tons and used on steep slopes.

3.6.6 Requirements for fire detection, mitigation, and prevention on mobile equipment:

a) The Protection Firefighting Systems (PFS) for mobile equipment must comply with PNR-000160 – Protection & Firefighting Systems – Mobile Equipment;

b) Mobile underground mine equipment must have fire suppression systems with automatic detection and manual activation from the cabin and at floor level, except for rigs and trucks with a useful load of up to 4 tons;

c) The automatic fire detection and suppression systems on mobile equipment must be maintained, inspected and available for use;

d) In addition to automatic fire detection and suppression systems, portable fire extinguishers recommended by the manufacturer must be available on mobile equipment;

e) Large water trucks must have automated water monitors to support firefighting on mobile equipment.

3.7 Requirements for procedures

a) All people that operate mobile equipment and/or that circulate in the operational roads or mining areas at Vale must comply with the following rules:
   I. Keep the equipment headlights on throughout the entire operation time;
   II. While the vehicle is not parked at a safe place, do not use TV / DVD, headset sound and mobile phone;
   III. **The road truck drivers must respect existing rules for crossing the level, such as:**
      - **Stop outside the level in a place which allows a wide view of both sides of the railway track;**
      - **Roll down the windows, turn off the vehicle radio and look in both directions;**
      - **Obey local signs and train passing alerts (horns);**
      - **Before crossing the railway, check if the other side of the highway is cleared and that there is no risk of stopping on the level passage;**
      - **It is prohibited to stop or maneuver a road vehicle on a passage level.**
   IV. Wear reflective clothing or waistcoats when circulating in operational areas and in mining areas;
   V. Wear reflective adhesive hardhats when circulating in underground mining areas;

b) All Vale Sites must have a Traffic Plan that includes the basic elements described in Annex II;

c) The operational areas where mobile equipment circulate must manage, in synergy with the Traffic plan, the following requirements:
   I. Access control of mobile equipment, motor vehicles and people to the mining areas;
   II. Definition of restricted areas;
   III. Telemetry management including:
      - System for periodic and routine verification of the information available;
      - Consequence Policy in cases of violations.
   IV. Drowsiness detection systems management, including:
      - System for periodic and routine verification of the information;
      - Actions to be taken in case of deviations.
   V. Tire pressure and temperature monitoring management, including:
      - System for periodic and routine verification of the information;
      - Actions to be taken in case of deviations.
   VI. Pre-use inspections;
   VII. Equipment checks and tests for release before first use and after maintenance, including brake testing according to the manufacturer specifications;
   VIII. Gas emission test in underground mining equipment;
   IX. Mandatory use of Tire Handlers to handle tires with an outside diameter of 1350 mm or greater;
   X. Operational conditions of automatic fire detection and suppression systems in mobile equipment;
   XI. Mobile equipment towing complying with the following hierarchy:
      - Use of tow truck;

- Use of float truck;
- Use of drawbar, approved by the Vale´s Engineering Department, only when the equipment has steering and brake systems in perfect working order.

XII. Mobile equipment removal, complying with local procedures that contain, at a minimum:
- Formal documented planning with risk analysis;
- Use of fiber cables with anti-whipping properties approved by Vale's Engineering area;
- Pre-use inspection of mobile equipment and towing accessories following applicable technical standards;
- Detailed periodic inspection of towing and rigging accessories in accordance with manufacturers' specifications and as provided for in local legislation; and
- Checks, tests and approval of equipment and accessories in the acquisition / contracting process before the first use.

XIII. Utilization of chocks[19] compatible with the tire dimensions of the mobile equipment and its implements and in sufficient numbers to block its movement in the following situations:
- In maintenance performed in workshops or maintenance stalls;
- In activities where the equipment must remain switched on and the operator must stay outside the cab, except in shift changes, which must take place at appropriate and safe locations for this activity;
- In parking lots;
- In case of mobile equipment that is damaged or needs to be temporarily parked on roads, access roads or sloped roads, with the operator outside the cab.

XIV. Manual positioning of excavator power cables, including the following:
- They must be supervised by an Electrician (skilled professional) carrying a two-way communication radio (exclusive channel);
- They must only be performed if the Operator of the excavator maintains eye contact with all persons performing the activity;
- They must only be carried on in good visibility conditions;
- They must be interrupted during thunderstorms or risk of lightning;
- They must be performed under the condition of zero energy in case the cable is submerged by water and/or mud.

XV. Mobile equipment in traffic under energized and non-insulated power lines at a distance of less than 6.0 meters, must be performed under the supervision of an Instructed Electrical Person and a Mine Operation Technician, who must have two-way radio communication with the Operator of the equipment;

XVI. An alcohol and drug testing plan must be implemented.

3.8 Requirements for training

Mobile equipment operators must have:

a) A valid driver's license for the type of mobile equipment, when required by local legislation;
b) Certification for the operation of the specific equipment type;
c) RAC 03 training, including refresher training, according to Valer guideline;
d) Training in the operation of the automatic fire detection and suppression systems, evacuation techniques and activation of the site emergency plan.

[19] The use of chocks is not mandatory when the equipment is on the outrigger floats or when the implement is lowered at ground level, which prevents its involuntary movement.

3.9 Roles and responsibilities

3.9.1 Leader of each location/site (Supervisor, Manager, or Director):

a) Implement the local Traffic Plan;

b) Implement the equipment requirements of this RAC;

c) Implement the specific procedures described in this RAC;

d) Approve modifications or the inclusion of safety accessories in the mobile equipment.

3.9.2 Leader of operation/project:

a) Document the inventory of mobile equipment in use at Vale's service in the location, whether by his own employees or contractors;

b) Document the inventory of operators authorized to operate mobile equipment, with the following information:

I. Type of mobile equipment;

II. Category and expiration date of the license;

III. Date of issue of certification for operation on the specific equipment type and date of next refresher coursin;

IV. Date of training in the traffic plan of the current operational area and in RAC 03 training, including refresher courses.

4. RAC 04 – LOCKOUT, IDENTIFICATION AND ZERO ENERGY

4.1 Foreword

A significant portion of fatalities and high potential incidents at Vale included cases where the energy sources were not adequately identified, locked out and tested. The main contributing factors associated with these incidents were: Inadequate or nonexistent application of lockout and identification;

a) Inadequate or nonexistent application of lockout and identification;

b) Inadequate or nonexistent test of the lockout effectiveness (zero energy);

c) Absence of lockout procedures or procedures that did not make provisions for the lockout;

d) Inadequate or inexistent lockout procedure/method;

e) Inadequate or nonexistent training;

f) Inadequate replacement of protection devices or did not ensure the safety integrity conditions;

g) Inadequate or nonexistent work planning/schedule;

h) Inadequate or nonexistent communication among work teams;

i) Inadequate or nonexistent lockout of potential gravitational energy sources;

j) Inadequate or nonexistent temporary change of the zero energy condition.

4.2 Purpose

To establish Health and Safety requirements to eliminate, control and minimize the risks of fatalities, injuries or incidents with release of hazardous energies.

4.3. Application

Maintenance and service activities in installations, machines and equipment, where the de-energization, lockout, identification, residual energy release and test procedures are required, to ensure the control of a potential hazardous energy release.

4.4 Exceptions

The requirements of this RAC do not apply to:

a) Activities in machines, equipment and installations where the existing safeguards ensure the effective protection of the workers from exposure to hazardous energies arising from an unexpected release, provided that the workers do not expose any part of the body to danger zones associated with the operation of the machine, equipment and installation;

b) Equipment which can be de-energized by unplugging from an electrical outlet, when the person performing the service or maintenance has exclusive control of the plug (works alone) and the electricity is the only hazardous energy source present;

c) Disassembly, removal and assembly of parts and pieces of machines, equipment, and systems, which are inherent steps of the maintenance process. The hazards created by the eventual movement of these pieces and parts, due to the disassembly, removal, and assembly, must be administered with specific maintenance procedures.

4.5 Important Definitions

- **Chemical energy:** the energy contained at the molecular level within a chemical substance. It is a measure of a substance's ability to transform into another substance through a chemical reaction that subsequently releases or absorbs energy.
- **Electrical energy:** energy from the flow of electric current due to the potential difference between two points in an electric field.
- **Energized:** connected to an energy source or containing residual or stored energy.
- **Energy source:** Any electrical, hydraulic, pneumatic, chemical, mechanical, nuclear, gravitational, residual, thermal energy.
- **Exclusive lockout:** type of lockout which makes the equipment, installation and parts exclusively available for a person or a work team to perform the activities. Equipment or installation becomes unavailable for other work teams.
- **Gravitational or potential gravitation energy:** the energy of an object (at rest or in motion) exerted by the gravitational force of the earth, such as moving or rotating parts supported by cables or hydraulic cylinders, counterweights, pelletizing discs, bucked wheels, truck cabins, etc. which can move through the energy action.
- **Hazardous energy:** the energy present in machines and equipment in operation or stored therein, with the potential to injure the workers seriously or fatally.
- **Hazardous energy treatment:** the action to prevent that a hazardous energy may harm people, using specific methods, when the lockout of the energy is not possible.
- **Hydraulic energy:** the energy obtained from the potential energy of a pressurized fluid. Under pressure, the fluid can move parts of machines and equipment.
- **Lockout device:** a method, such as a lock, to keep the switching or disconnecting device in a secure position to prevent energization of a machine or equipment.
- **Lockout of hazardous energies:** the act of removing, disconnecting, and preventing the inadvertent restoration of energy. It includes the removal and the disconnection of energy sources, the discharge/release of the residual energies, the lockout and/or blocking, the attachment of tags and testing the removal or disconnection of the hazardous energy.
- **Lockout matrix:** document or computerized system indicating **all** the energy sources and blocking points associated to each machine, equipment, system, and installation.
- **Lockout of hazardous energies:** specific practices and procedures to protect the workers from an unexpected energization or startup of machines and equipment or from the release of hazardous energy during the maintenance and service activities.
- **Local procedure:** written document establishing the specific guidelines and requirements applicable to a given board, industrial unit, or operational area.
- **Mechanical energy:** the energy that can be transferred by means of a force on an object.
- **Pneumatic energy:** the energy produced from compressed air inside a closed system.
- **Radioactive energy:** the energy produced because of a fission or fusion reaction during a molecular transformation of unstable atomic nuclei.
- **Residual Energy:** accumulated energy which can remain after the disconnection of a feed source, representing a danger to the people exposed. The residual energy must be eliminated before the execution of the service, in order to achieve the zero-energy state.
- **Switching or disconnecting devices:** devices that interrupt, divert, or prevent the flow of an energy source, such as disconnect switches, valves, dampers, registers, circuit breakers, etc.

- **Tag:** individual identification card with name, date, time, and reason for the lockout, with an attachment means which can be securely attached to an energy lockout device according to an established procedure. The tag attached to a device indicates that the energy switching or disconnecting device and equipment cannot be operated until the tag and the lockout device are removed.
- **Team:** Group of people from a company or a specialty, performing a specific task.
- **Thermal energy:** the energy generated by the kinetic energy of the atoms of a substance.
- **Zero energy state:** condition of the equipment, installation, and system where all forms of energy are under control through the lockout and/or deactivation. It is the ideal state for people to access the equipment, system, and installation.

4.6 Requirements for installations and equipment

a) Machines, equipment and installations must be clearly identified;

b) Machines, equipment and installations must allow the use of lockout devices;

c) Switching or disconnecting devices must be clearly defined, according to local documentation, and must be preferentially designed as permanent physical installations;

d) Process flows and electrical drawings must be up-to-date so that the switching and disconnecting devices may be referenced and identified in the lockout procedures;

e) Lockout devices must comply with the following requirements:

   I. Be durable to withstand the environment;

   II. Be designed to directly allow the use of locks;

   III. Have mechanical integrity and not allow tampering;

   IV. Follow the standard established in the local procedure.

f) The locks must comply with the following requirements:

   I. Be designed for energy lockout purposes and have at least 6 pins;

   II. Be single key;

   III. Not be combination type locks;

   IV. Retain the key while open;

   V. For use in electrical energy sources, be built of nonconductive materials.

g) The lockout tags must comply to the following requirements:

   I. Be durable to withstand the environment;

   II. Be traceable;

   III. Indicate the person's name, the date, time and reason for the lockout;

   IV. Follow the standard established in the local procedure.

h) For equipment powered by electrical energy, which switching devices are located in substations, electrical rooms or motor control centers (MCCs) there must exist, **preferentially**, a **computerized** system to manage the steps of the electrical energy lockout, ensuring, as a minimum:

   I. The identification of the forms of energy linked to the lockout equipment;

   II. Compliance to all steps and authorizations of the lockout and removal flux process.

4.7 Requirements for procedures

There must be local procedures that include as a minimum:

a) Roles, responsibilities and approvals;

b) Method that persons working on equipment under lockout must use to install their locks and tags. One of these methods is to place their locks and tags on the switching or disconnecting devices, and the other method is to place the locks and tags in a lockout box;

c) Steps for shift changes;

d) **Updated** lockout matrix that includes, as a minimum, the identification of all hazardous energy sources (electrical, hydraulic, pneumatic, chemical, mechanical, radioactive, gravitational, thermal, residual, where applicable) and the lockout points associated with each machine, equipment, system and installation; P!

e) All persons working on equipment under lockout must place their locks and tags on switching or disconnecting devices or in the lockout box before beginning their tasks. Only the persons who placed the lock and tag can remove them; P!

f) Special authorization from the Area Manager in case of a condition that prevents the regular removal of the lock, such as, for example, the loss of a key or the absence of a performer, among others, including the analysis of the hazards involved;

g) Prohibition of damaging or violating any form of lockout applied in machines, equipment and installations;

h) Mandatory tests to verify the effectiveness of the lockout (zero energy) before starting the service; P!

i) Control measures based on the Task Risk Analysis, which eliminate the exposure to hazardous energies, approved by the Area Manager, when it is not possible to obtain the zero energy state;

j) Additional control measures to the equipment which may re-accumulate energy during the execution of the activity;

k) Assignment of an authorized professional to verify that all required lockouts were correctly done in case there is more than one team involved in activities in the same equipment/machine locked out;

l) The application of exclusive lockout by a person or team must be adopted when the execution of simultaneous activities on a machine or equipment may impact the safety of other people; P!

m) Steps to temporary changes in the zero energy state, with the temporary introduction of energy to perform tests in machines, equipment and installations under lockout, considering the following items:

I. Exclusive lockout of the machine, equipment and installation;

II. Risk analysis associated to the temporary change(s);

III. Application of the required control measures;

IV. Communication of the change(s) to all people involved who are working under the lockout;

V. Interruption of the work of all people involved who are not directly performing the tests which require the temporary introduction of the energy;

VI. Temporary change(s) in the lockout;

VII. Confirmation by the authorized professional that all the required control measures were correctly applied;

VIII. Performing the tests;

IX. Return of the lockout to its previous zero energy condition, removing the temporary introduced energy and returning all disconnecting devices to their position according to the initial lockout;

X. Confirmation by the authorized professional that the lockout has been returned to its original zero energy condition;

XI. Communication of the lockout return to all people involved who are working under the lockout

XII. Resumption of work originally scheduled under the lockout.

n) Unlock process of the energy source(s) including, as a minimum, the confirmation that:

I. All people involved have completed their activities and are out of the risk area;

II. The tools and pieces were removed from the risk area;

III. The mechanical or electrical protections, individual or collective, were returned to their original condition.

4.8 Requirements for specific lockout procedures per equipment/group of equipment

There must be specific lockout procedures that include, as a minimum:

a) **Scope of the maintenance and service activity(ies);**

b) Identification of the equipment to be locked out;

c) Verification that all energy sources have been identified;

d) Disconnection or interruption of the energy source;

e) Release of the residual energy, including additional measures to prevent energy re-accumulation, when applicable;

f) Application of lockout devices and tags in each energy source;

g) Test to verify the effectiveness of the lockout (zero energy);

h) Control measures which eliminate the exposure to the hazardous energies, based on the Task Risk Analysis, when it is not possible to obtain the zero energy state, approved by the Area Manager;

i) Additional control measures for the equipment which may re-accumulate energy during the execution of the activity;

j) Steps to be followed when a temporary change of the zero energy state is needed, complying with the local procedures;

k) Steps to unlock the equipment, complying with the local procedures.

4.9. Requirements for training

The workers involved in activities that require lockout must be training in Lockout, Identification and Zero Energy.

4.10. Roles and responsibilities

4.10.1. Directors:

a) Formally assign one or more persons responsible for developing and maintaining the following processes/ procedures/ controls:

I. Local procedures and specific lockout procedures per equipment/group of equipment;

II. Lockout Matrix;

III. Formal management system of the steps of the energy lockout process of equipment powered by electrical energy which switching devices are located in substations, electrical rooms or motor control centers (MCCs);

IV. Training and evaluation program of the workers involved in the lockout, tagging and test of hazardous energy process;

V. Program to verify the effectiveness of the implementation of the requirements described in this document;

VI. Resources needed to implement the control of hazardous energies.

4.10.2. Managers:

a) Approve local procedures and specific lockout procedures per equipment/ group of equipment;

b) Formally approve the workers authorized to execute the lockout of hazardous energies;

c) Formally assign the persons responsible to confirm that all required lockouts were correctly done when there is more than one team involved in activities in the same locked out equipment.

4.10.3. Workers involved in hazardous energy lockout processes:

a) Comply with the requirements established in this document, in the local procedures and in the specific lockout procedures per equipment/ group of equipment.

4.10.4. All Vale and contractor employees:

a) Comply with the requirements established in this document, in the local procedures and in the specific lockout procedures per equipment/ group of equipment.

5. RAC 05 – LIFTING OF LOADS

5.1 Foreword

A significant proportion of critical incidents in Vale occurred during the lifting of loads. The main contributing factors associated with these incidents were:

a) Use of inadequate tool / equipment.
b) Inadequate position for the task.
c) Failure to alert / warn / communicate.
d) Improper loading / tethering.
e) Failure to identify and assess risks.
f) Unintentional deviation from working standards.
g) Defective / inappropriate tool / equipment.
h) Inadequate lifting / lifting.

5.2 Purpose

To establish requirements for lifting loads at Vale's, to eliminate or control the risk of injuries or fatalities.

5.3 Application

Activities associated with the lifting of loads by equipment owned, leased or rented by Vale, including service provider lifting equipment, of the following types of lifting equipment: cranes, overhead cranes, monorail lifting systems, lifting booms, hoists and any other lifting equipment or lifting system[20].

The activity of lifting, the preparation and modifications made to the equipment and the load to be lifted are included in the scope.

5.4 Exceptions

The requirements of this RAC do not apply to:

a) Load transport activities by vehicles or equipment; Example: transport by trucks, trailersor forklifts;
b) Maintenance[1] of load lifting equipment except when, in the maintenance activity, there is lifting;
c) Operation of vehicles designed for lifting loads when not involved in the lifting activity;
d) People lifting activity.

5.5 Important definitions

- **Accessories**: Connection elements positioned between the load and the pulley, used to support the load during the lifting. Examples of accessories: shackles, synthetic webbing slings, chain slings, wire ropes, forged fittings and special devices.
- **Utilization Factor or rate:** is the ratio between the gross load of the crane to be hoisted and its capacity according to its load chart and configuration.
- **Critical Lifting:** Any lifting that has at least one of the mandatory conditions for the elaboration of a Rigging plan **(see item 5.7 - Requirements for procedures, letter ´f´).**
- **Rigging Plan: This consists of the formalized planning of a move with a mobile or fixed crane, aimed at optimizing the resources used in the operation (equipment, accessories, and others) to avoid accidents and wasted time. It indicates, by studying the load to be lifted, the machines available, accessories,**

[20] Even if not listed in this document, any load lifting equipment must comply with the general requirements (not specified for a specific type of equipment) for equipment/installations and procedures set out in this RAC.

ground conditions and wind action, which are the best solutions for safe and efficient lifting.equirements for iequipment

5.6 Requirements for installations and equipment

5.6.1 General requirements for installations and equipment:

a) Visible indication of the maximum load handling capacity on lifting accessories and equipment;
b) Hooks with safety locks on load lifting accessories;
c) Load lifting accessories must comply with technical standards and/or local legislation;
d) **Sling protection attached to the load or accessories must be used to protect them from damage caused by sharp edges.**

5.6.2 Specific requirements according to equipment:

Specific Requirements	Tower Crane	Vehicle-mounted crane	Other Cranes	Overhead Crane	Monorails [21]	Electric Hoist	Manual Gantry
a) Load table fixed next to the control Levers	X	X	X				
b) Movement sound alarm	X			X		X[22]	
c) Top lights	X						
d) Grounded structures	X			X	X	X	
e) Outriggers pressure monitoring			X[23]				
f) Outriggers leveling checking system or device		X	X				
g) Extensions and outriggers with hydraulic drive		X	X				
h) h.1 End stop limit switch for translational movements of the equipment			X			X	
h.2 Upper and lower end stop limit switch for lifting system movements				X		X	
i) Sensor or device that identifies the loose cable	X		X	X		X	
j) Anti-collision sensors[24]				X		X	
k) Remote control (Joystic) for load movement		X					
l) Inclinometer that prevent lifting of load with improper cable angulation				X			
m) Boom with hydraulic drive		X					
n) Locking casters							X

[21] The requirements for the monorail are for the structure itself. Equipment (such as trolley with a hoist) that will be supported on the monorail must comply with their specific requirements.
[22] Except for fixed hoist.
[23] **Only for equipment that performs critical lifting (requirement 5.7.f)**
[24] Only for two or more overhead crane in the same interspace.

Specific Requirements	Tower Crane	Vehicle-mounted crane	Other Cranes	Overhead Crane	Monorails [21]	Electric Hoist	Manual Gantry
o) Anemometer	X		X[25]				
p) Emergency button	X	X	X	X		X	
q) Overload sensor, with stop of equipment and audible/visual alarm when rated capacity is exceeded		X	X	X		X[26]	
r) Winch safe brake system	X			X		X	

5.7 Requirements for procedures

a) Isolation of the lifting area must be implemented considering:
   I. The perimeter of the load travel;
   II. The perimeter of the equipment boom;
   III. The equipment outriggers.
b) The use of plastic tape for area isolation is prohibited;
c) Where lifting activities take place over equipment and facilities, the isolation must take into consideration the magnitude of an unwanted event based on the fall of the load and the consequent collapse of the structure below;
d) Radio communication between operator and signalman must occur on an exclusive frequency;
e) It must be adopted:
   I. Pre-use inspection of lifting equipment and accessories, (in accordance with the requirements of the respective applicable standards);
   II. Detailed periodic inspection of lifting accessories in accordance with manufacturers specifications and local legislation;
   III. Verifications, tests and approval of equipment and accessories at the time of acquisition / procurement before the initial use.
f) A Rigging Pla[27]n must be developed for critical lifts with a wheeled/tracked crane, articulated vehicle crane and crane, if at least one of the following conditions is met:
   I. lift exceeds 10 tons;
   II. Total load equal to or is greater than 75% of the maximum capacity of the lifting equipment, based on the limits of the loading table to the corresponding distance over which it will be lifted;
   III. Where two or more cranes are involved;
   IV. Near electrical overhead lines;
   V. Loads with large and irregular shape;
   VI. With large and irregularly shaped loads.
g) The minimum content of the rigging plan must follow Annex III of this document;
h) The maximum capacity of any lifting equipment and accessories must be respected;
i) In disassembly activities, when a crane is used to support a load during the removal of its support points in the structure where it is mounted, the limit of 70% of the operation utilization factor must be adopte;
j) Defective and/or worn-out lifting accessories must be discarded;
k) The equipment's outriggers must be fully extended **if the manufacturer does not allow partial opening;**
l) When not defined in the Rigging Plan, the pads of outriggers must be shimmed with a slab area of at least twice as large as the outrigger area;

[25] Only for cranes with capacity above 75 ton.
[26] **Not applicable for chain hoists that have a friction clutch device.**
[27] A Rigging Plan is considered to be a specific type of formal documented planning, with the minimum established in this document. Hoists that do not require a Rigging Plan must also be planned and undergo a risk analysis.

m) It is forbidden to for people to interact with (touch) a suspended load. Instead, guide cables or other devices must be used whenever stabilization is required. In situations of fine adjustments, in the absolute impossibility of completing the lifting without touching the suspended load, the following conditions must be respected:
- It is not allowed to touch under the lifted load;
- It must be ensured that the hands and feet are out of the line of fire of the load, thus avoiding possible crushing of the limbs;
- A free area must be ensured around those involved, avoiding possible crushing in case of load balance.

n) The positioning of people under or within the radius of action of the suspended load is prohibited.

o) It is forbidden to access an isolated area for load lifting without authorization.

p) **It is prohibited to lift loads using improvised or adapted equipment, except with express authorization from the manufacturer or engineering project containing technical responsibility.**

q) The load to be lifted must be properly tied according to its type, dimensions, weight and accessories to be used.

5.8 Requirements for training

Performers must receive the following training:

a) Operation of lifting equipment;
b) Signaling and load lashing;
c) Inspection of lifting accessories;
d) For the responsible for the Rigging plan:
I. Training for preparing the Rigging plan, for the person who will make it;
II. Training for the supervision of the Rigging plan, for the designer.
e) Training in RAC 05 and the local lifting procedure, including refresher training, in accordance with the RAC Training Guidelines.

5.9 Roles and responsibilities

5.9.1 Owner of the area and Contract manager:

a) Ensure compliance to the RAC in his contract;.
b) Follow the services suppliers 'safety performance and requirements compliance;
c) Participate in any investigations related to incidents involving load lifting activity.

5.9.2 Maintenance Planning and scheduling[28]:

a) Need to know the RAC requirements applicable to the activities of their areas;
b) Ensure that risk analyses in lifting activities are initiated at the stages of their respective work processes;
c) Provide basic data - identification, weight, and dimensions - about the load to be lifted.

5.9.3 Rigging supervisor:

a) Coordinate, guide and follow all steps related to the load lifting activities that are covered by Rigging Plans;
b) Follow all RAC´s requirements RAC in line with the calculations and requirements of the Rigging plan.

[28] Maintenance, infrastructure, and projects.

5.9.4 Tool shop supervisor and/or resources (materials)

a) Establish an inspection plan for the accessories;
b) Ensure that the load accessories are inspected periodically and when they are returned after use;
c) Segregate all non-conformity accessories and send for disposal.

5.9.5 Signalman and employee who ties the loads:

a) Define the way of tying the load to be lifted, as well as the accessories to be used;
b) Carry out pre-use inspections of the accessories;
c) Define the isolation area with the crane operator;
d) Communicate with the operator of the equipment using standardized hand signals, or via radio.

5.9.6 Rigging plan developer:

a) **Develop a Rigging plan in accordance with Annex III of this document.**

6. RAC 06 – CONFINED SPACES:

6.1 Foreword

A significant proportion of critical incidents in Vale occurred in confined spaces. The main contributing factors associated with these incidents were:

a) Lack of risk perception;
b) Lack/failure of signaling;
c) Failure in the previous assessment / preparation for entry confined space;
d) Failure to calibrate atmospheric monitoring meters;
e) Lack/failure to monitor contaminants in the atmosphere;
f) Excess or lack of oxygen;
g) Lack/failure to block hazardous energy;
h) Lack/failure of PPE;
i) Lack of adequate ventilation/exhaustion;
j) Lack / failure to control access;
k) Lack / failure to communicate.

6.2 Purpose

Establish minimum Health and Safety requirements for recognition, identification, assessment, monitoring, control and mitigation and response to emergencies in activities in which workers interact directly or indirectly with confined spaces.

6.3 Application

The requirements of this RAC are applicable to access and/or execution of activities in confined spaces with the aim of preventing injuries and fatalities in people entering these places.

6.4 Exceptions

Locations where the definition of confined space (6.5) does not apply.

6.5 Important definitions

- **IDLH Atmosphere (Atmosphere Immediately Dangerous to Life or Health): any atmosphere that presents an immediate risk to life or produces an immediate debilitating effect on health;**
- **Hazardous atmosphere: where one of the following conditions is present:**

  I. oxygen deficiency or enrichment;

  II. presence of contaminants with the potential to cause harm to worker health;

  III. be characterized as an explosive atmosphere.
- **Confined space: any area or environment that simultaneously meets the following requirements:**

  I. is not designed for continuous human occupation;

  II. have limited means of entry and exit; and

  III. in which a dangerous atmosphere exists or may exist.

  IV. NOTE: Places not intended for human occupation (a), and which have limited means of entry and exit (b), used for storing material with the potential for engulfment or drowning are characterized as confined spaces.
- **Contaminants: gases, vapors, mists, fumes and dust present in the atmosphere of the confined space.**

- **Oxygen deficiency: atmosphere containing less than 19.5% oxygen by volume at normal atmospheric pressure.**
- **Oxygen enrichment: atmosphere containing more than 23% oxygen by volume at normal atmospheric pressure.**
- **Engulfment: envelopment and capture of a person by finely particulate liquid or solid material, capable of causing unconsciousness or death, which can be aspirated, filling or clogging the respiratory system or which can exert sufficient force on the body to cause strangulation, constriction or crushing.**
- **Figure 8: consists of a racket and a spacer. It is installed between flanges to safely block hazardous energy upstream (top) of the line or pipe, to protect the downstream (bottom) of the line or pipe.**
- **Inertization: displacement of the existing atmosphere in a confined space by an inert gas, resulting in a non-combustible atmosphere with a deficiency of oxygen.**
- **Rescue plan: previously written document, to be used by the team that will carry out the rescue, containing the rescue planning and first aid.**
- **Biological risks: activities in confined spaces (tunnels, galleries, etc.) in vegetation areas can encourage contact with bats, rats, snakes, fungi, parasites, etc.**
- **Ergonomic risks: heavy lifting, excessive work pace, monotony, repetitiveness, inadequate working posture, etc.**
- **Physical risks: noise, heat, cold, pressure, humidity, ionizing and non-ionizing radiation, vibration, etc.**
- **Chemical risks: dust, fumes, mists, vapors, etc.**
- **Entry supervisor: person trained to issue the applicable confined space entry annex (PNR-000031), and ensure that safe conditions remain during work on site.**
- **Authorized worker: worker trained to enter the confined space with knowledge of the risks and existing control measures.**
- **Watchman: worker designated to remain outside the confined space and who is responsible for monitoring safe working conditions, communication and activating the emergency plan.**

6.6 Requirements for installations and equipment

a) Confined spaces must have identification signs and physical barriers to warn and prevent inadvertent or unauthorized access;

b) Breathing air supply systems must comply with local legislation and the Respiratory Protection Program (PGS-004097);

c) The ventilation/exhaust system must be sized for the characteristics of the confined space, observing applicable technical standards and local legislation;

d) Electronic movement sensors must be used on people entering confined spaces when the watchman cannot see them (examples: tunnels, galleries, etc.);

e) Drones (annex IV - Drone data sheet) must preferable be used for inspection work in confined spaces.

6.7 Requirements for procedures

6.7.1 General requirements for general procedures for confined spaces:

a) There must be an updated inventory of all confined spaces, including deactivated ones, with their respective risks, **preferably registered in the Proteger System;**

b) Places not intended for human occupation, and which have limited means of entry and exit (even if they do not have a dangerous atmosphere), used for storing material with the potential for engulfment or drowning must be characterized and inventoried as a confined space;

c) All devices, tools and equipment used in activities must be previously inspected, including support equipment and which will not be inserted into the confined space;

d) Multigas meters, oxyexplosimeters and all others that require calibration must be properly calibrated and tested (bump test) before use, in accordance with the **manufacturer's instructions, applicable technical standards** and local legislation;

e) Authorization to enter the confined space must be registered using PNR-000031 and applicable annexes.

6.7.2 Requirements for planning of entry in confined spaces:

a) Entries into confined spaces must be previously evaluated, planned and programmed in a way that includes risk analysis and procedures covering the steps of:

I. Procedure for confined spaces;

II. Risk analysis (considering accident, biological, ergonomic, physical, chemical risks, etc.) with specific steps for preparation, entry and activities to be performed;

III. Emergency and rescue plan with specific scenarios for the confined space.

6.7.3 Requirements for preparation, entry and activities into confined spaces:

a) The following hierarchy must be complied with for blocking **hydraulic, mechanical, pneumatic, chemical and thermal energy** in the confined space:

I. Physical disconnection;

II. Installation of blind flanges / paddles / spectacle blind;

III. Application of double block and bleed.

b) The percentage of oxygen (O2) to enter confined spaces must be between 19.5% and 23% of volume;

c) Entering to the confined space with an IDLH (Immediately Dangerous to Life and Health) atmosphere is only permitted with the use of a self-contained breathing apparatus (SCBA) with positive pressure demand or a respirator with a breathing air line with an auxiliary escape cylinder;

d) Monitoring of air quality in the atmosphere must be continuous while the workers are inside the confined space;

e) Monitoring of contaminants in the atmosphere, when necessary, must comply with the frequency (initial, periodic or continuous) according to the risk analysis;

f) Ventilation / exhaust systems (air supply) must be continuously checked;

g) When there is equipment and accessories to supply breathing air, the respiratory protection program (PGS-004097) must be complied with and the systems must be continuously checked;

h) The communication system must be operational and available (work team / watchman / rescue team);

i) Individual access control (entry and exit) of authorized workers must be maintained **during all activities;**

j) The rescue team must be notified in advance regarding the confined space entry scenario to be carried out and the respective activities to be carried out in these spaces;

k) Protocols for thermal stress must be established, including a work rest regime, according to the risk analysis.

6.7.4 Requirements for emergency procedures in confined spaces:

a) Emergency, rescue and simulated plans in confined spaces must comply with the requirements of PNR-000066 Emergency Response Management.

b) Emergency response equipment must be available according to the dimension of the PAE – Emergency Response Plan for the location.

6.8 Requirements for training

a) Confined space supervisors must be trained in RAC 06, PNR-000031, the confined space procedure and local legal requirements for confined space work;

b) Confined space watchman must be trained in RAC 06, the confined space procedure and local legal requirements for confined space work;

c) Workers performing activities within confined spaces must be trained in RAC 06, the confined space procedure, and local legal requirements for work in confined spaces.

6.9 Roles and responsibilities:

a) The Entry Supervisor must:

I. Issue the applicable annex of PNR-000031 for confined space entry before the start of activities;
II. ensure that tests of atmospheric monitoring equipment have been carried out and validated;
III. Ensure that atmospheric monitoring has been carried out and continues to be carried out continuously;
IV. ensure that emergency and rescue services are available and that the means for activation are operational;
V. ensure the presence of the watchman (s) during entry and during of activities in the confined space.

b) The watchman must:

I. not perform other tasks during watchman activities;

II. allow only authorized workers listed in the applicable annex of PNR-000031 to enter the confined space;

III. continuously maintain control of authorized workers within the confined space during activities, and ensure that everyone leaves at the end of the activity;

IV. stay outside the confined space, near to the entrance;

V. In case of emergency, order the immediate exit of all people from the confined space;

VI. In case of emergency, activate the emergency and rescue plan;

VII. Report any unforeseen or unusual event to the entry supervisor, including when an emergency abandonment order is issued.

c) Authorized workers must:

I. comply with the guidelines received in training and described in the procedures;

II. communicate health and safety risk situations to the guard or entry supervisor.

7. RAC 07 – MACHINE GUARDING:

7.1 Foreword

Some of the accidents at Vale have occurred during critical activities involving machines with unguarded moving parts. The main contributing factors associated with these accidents were:

a) Absence of physical protection (fences, shields, etc.);

b) Absence of automatic protective devices (presence sensors, light curtain, interlocks, controllers, actuators, etc.);

c) Guards being removed and/or not reinstalled after machine maintenance;

d) Inadequate safeguarding;

e) Lack of awareness of machine risks;

f) New and existing machines not complying with technical standards for machinery safety.

7.2 Purpose

To establish minimum requirements on machine guarding for acquisition, installation, commissioning, operation and maintenance activities to prevent accidents.

7.3 Application

This document applies to all new and existing machines at Vale's facilities and at those of our contractors/third parties, such as:

a) Fixed or mobile machines and associated installations, both new designs and existing;
b) Standard machines purchased from suppliers, including those adapted for Vale;
c) Machines manufactured specifically for Vale;
d) Modifications made to existing machines and associated installations.

7.4 Exceptions

The requirements of this RAC do not apply to:

a) Non-installed parts, components or pieces of interchangeable equipment that by themselves do not constitute a machine (hydraulic units, robots, etc.);
b) Lifting accessories such as chains, ropes and steel cables;
c) Partly completed machinery, that are not yet in operation;
d) Machinery designed for:
   I. Nuclear and/or windmill power generation purposes;
   II. Use onboard seagoing vessels and mobile offshore units;
   III. High-voltage electrical equipment (generators, transformers, etc.).

e) Power portable tools. For this item, PGS-005227 General Requirements for the Safe Use of Power Portable Tools must be applied.

7.5 Important definitions

- **Control device:** Mechanisms used to control a machine function.
- **Effectiveness**: Compliance with technical standards to ensure the proposed risk reduction. Examples include safety distances, performance levels, integrity of structures, etc.
- **Hazard:** A potential source of injury or damage.
- **HRN:** Hazard Rating Number used to estimate a risk.

- **Interchangeable equipment:** A device other than a tool which, after being put into service in machinery, can be changed by operation/maintenance to a different function (e.g., exchanging an excavator shell for a stone crusher).
- **Machinery: machines and equipment with at least one mobile component, for non-domestic use and moved by non-human force.**
- **Maintenance:** All activities to repair and keep assets in good order, including planned predictive, preventative, corrective maintenance, problem solving and failure repair.
- **Operation:** All activities performed during the normal operation of our work, such as production, set-up, changeover, and cleaning.
- **Partly completed machinery:** An assembly which is almost fully functional, but which cannot in itself perform a specific application. It is only intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.
- **PL:** Performance level.
- **PLr:** Required performance level.
- **PPE:** Personal protective equipment.
- **Risk:** A combination of the possibility for and the degree of injury or damage.
- **MT**: The mission time duration in which a security component can be used. This represents the reliability of a component with respect to its safety performance.

7.6 Requirements for installations and equipment

7.6.1 General requirements:

NOTE 1: Details of the requirements of this RAC are available in PGS-004951 – Machine Guarding Manual, which describes the best implementation and safety practices.

a) Machines and safeguards must comply with technical standards and local legislation. Machine Guards must have project developed by a qualified professional;

b) Machinery must be designed and constructed in such a way that prevents people being exposed to a hazard in any level. To avoid or reduce exposure to the hazard, the criteria in this table must be met:

Exposure level to hazard	**1**	**2**	**3**	**4**	**5**
Task characteristics	Work outside safeguards	Work through safeguards	Work inside the machine, behind safeguards	Work near hazardous energy/ movements	No safeguards, everything is off
Task	Normal operation		Clearing jams / Tool change, etc.	Set-up, adjustment, process monitoring, etc.	Maintenance

Safety measures	Fixed guards or perimeter fencing	Protective devices	Key exchange / trapped-key interlock, multiple reset, tag system, partial lockout/tagout, etc.	Partial lockout/tagout / alternative measures	Lockout, tagout and zero energy (RAC 04)

c) Hazardous energy-isolating devices (RAC 04) must be installed in an easily accessible location with sufficient space in which workers can stand when switching them on and off, allowing them to be locked out in the off position;
d) All operating panels and components that require regular service must be located outside safeguards;
e) All systems, components and devices used to perform a safety function (e.g., an interlocked protection interconnected to the safety relay that disables the operation of a motor) must be certified for use as a safety system by the manufacturer or by a recognized testing body;
f) Where there is a risk of projecting or liquid or solid falling materials that could reach people, suitable guards must be installed to prevent accidents;
g) The control systems of machines (e.g., start buttons, mode selectors, gate interlock systems connected to the machine safety stop interface, emergency stop systems, etc.) must be designed and constructed in such a way as to prevent the occurrence of hazardous situations, with special attention to:
   I. Prevention of unexpected start-up of machinery,
   II. Prevention of uncontrolled changes;
   III. Priority over other controls;
   IV. Visibility of the operation, etc.
h) **Operation interface devices** (e.g., start buttons, buttons, pedals, door keys, etc.) must be designed and constructed in such a way as to prevent the occurrence of hazardous situations, with special attention to:
   I. Operation in an accessible way,
   II. Safe position,
   III. Clarity of functions and positions,
   IV. Audible and visual signaling (start-up, anomaly, overload),
   V. Commands and selection modes activated by voluntary actions, etc.
i) To prevent access to moving parts, movements and dangerous areas of the machine, fixed mechanical protections must be installed (examples: grilles, screens, covers, screens, etc.), mobile (examples: interlocked doors, interlocked fitted protections) and safety devices. protection (examples: light curtains, scanner, etc.);
j) Guards must be selected according to the table below:

Frequency of access	Guarding type	Fixing	Interlock device required
Never	Fixed guards	Bolted / welded	No
Annual	Fixed guards	Bolted	No
Weekly	Fixed or moveable guards	Bolted (if fixed)	Yes (if moveable)
Daily	Moveable guards	N/A	Yes
Hourly	Moveable guards	N/A	Yes
More than hourly	Protective device	N/A	No

k) Guards in general must:
   I. Feature suitable construction and materials for their intended use and environment;
   II. Adequately accommodate the frequency of access.

l) Fixed guards must:
   I. Only be opened or removed with use of a tool;
   II. Feature easy and safe handing for maintenance purposes;
   III. Observe safety distances to prevent hazardous zones from being reached over, through and under.

m) Moveable guards must:
   I. Ensure interlocking, initiating machine stop when the guard is opened;
   II. Feature design and construction that allow them to be opened without a tool;
   III. Stay closed and locked until the risk of injury from the hazardous machinery functions has ceased, included the inertia movement.

n) Protective devices must:
   I. Ensure detection of people in dangerous areas;
   II. Prevent unexpected start-ups when people are in the hazard zone;
   III. Generate a stop command when the hazard zone is infringed, which must be sufficiently quick to prevent access to hazard zones;
   IV. Must, where it is possible for a person to reach the hazard zone before the dangerous movements stop (e.g., due to inertia), be installed with a guard-locking device.

o) Machine fluid systems must:
   I. Be equipped with protective and restraining systems by suitable means (adequate hose support, air fuses, shielding, etc.) to avoid whiplash caused by hose or pipe failures;
   II. Have a performance level (PL) adequate.

p) Machines must be equipped with 1 (one) or more emergency stop devices to allow them to stop in an emergency, removing the power from the machine actuators in the best possible conditions;

q) Safety control systems (e.g., interlocking connected to safety relays and actuators) must perform specified functions to achieve or maintain a safety machine/process state when unacceptable or dangerous process conditions are detected;

r) Safety control systems must allow for the achievement of performance levels (PL) in accordance with the risk related to the safety function;

s) The required performance levels (PL_R) of the safety functions must comply with the table below:

Inherent risk level, unguarded	PL_R	Min. safety category
Low	c	1
Medium	d	3
High	d	3
Very high	e	4

NOTE 2: ISO 13849-1 – Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design may alternatively be followed to determine the PL_R.

t) All energy sources must be designed and installed so that they do not endanger the safety or health of persons working on or nearby the machine.

u) Machinery must be provided with measures to prevent unexpected start-ups that can either be applied automatically (e.g., via a control system) or manually (e.g., via the control of hazardous energies.

v) Warning devices (preferably audible or visual) must be provided whenever the presence of persons in hazard zones of machines is difficult to notice. Such warning systems must alert personnel about the impending machine start-up, according to item 7.3 of PGS-004951 – Machine Guarding Manual.

w) Warning signs (markings, pictograms, standardized colours, and written text in a local official language) must be used to indicate residual risks remaining in the machine, according to item 7.15 of PGS-004951 – Machine Guarding Manual.
x) Safe access to machines and the entire installation set must be designed and constructed for operation, adjustment, maintenance, cleaning activities, etc.

NOTE 3: Means of access to the machines must be protected with a guardrail where there is a risk of falling (into the machine, or around the machine) over a height over 500 mm = 0.5 meters = 19.68in.

NOTE 4: Guardrails on escape routes must comply with the guidelines of PNR-000127 – Facility Layout – Escape Routes.

7.7 Requirements for procedures

7.7.1 General requirements:

a) Each location must have an inventory of its own machines and those of contracted companies;
b) Each location must be provided with an inspection or maintenance plan (for Vale's own machines) and/or an inspection or maintenance procedure (for machines from contracted companies) for verifying the effectiveness and reliability (TM – Time mission) of the machines' protective systems and safety components, in accordance with the information from the manufacturer or most restrictive plan at Vale's discretion. The plan must include at least:
   I. Fixed guards – fences, shields, mesh guards, fastening, etc;
   II. Moveable guards – interlocked gates, fastening, logics, etc;
   III. Automatic protective devices – presence sensors, light curtains, interlocks, controllers, actuators, etc;
   IV. Emergency stop devices – pushbuttons, ropes, etc.
c) Machine guards that are removed must be put back in place before the machine is returned to operation;
d) **Removed or damaged safety devices that cannot be repaired and/or replaced during routine maintenance, safety contingency measures must be adopted with tolerable risks until the problem is permanently resolved. The permanent solution must be reestablished as quickly as possible**.

7.7.2 Risk assessment (HRN methodology):

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a) For all new and existing machines at Vale, a risk assessment must be carried out using the HRN methodology. Risk assessments of machines owned by Vale must be recorded in the Proteger System**;**
b) For all machines contracted by Vale, the supplier must deliver and maintain an updated risk assessment in accordance with local legislation;
c) The result of Vale's risk assessments must be expressed as per the table below:

HRN	MACHINE RISK LEVEL	TOLERABILITY (ISO 12.100)
> 500	Very high	Not acceptable, requires risk reduction measures.
> 50 up to 500	High	Not acceptable, requires risk reduction measures.
> 5 up to 50	Medium	Tolerable, may require risk reduction measures.
0 up to 5	Low	Acceptable, does not require risk reduction measures.

d) After the risk reduction measures are implemented, the risk assessment must be updated, keeping the initial risk assessment for reference;
e) The risk assessment of machines in operation must be reviewed after operational changes or design modifications are made or an accident occurs (e.g., changes in operating parameters, newly introduced risks, changes in risk estimation parameters).

7.7.3 Procedure for acceptance of new machines:

a) New machines must only be accepted upon presentation of a risk assessment report following the HRN methodology **(acceptable and tolerable levels)** and indication of the achieved PL (Performance Levels) of each safety function of the machine;
b) Verification, validation and acceptance tests of safety systems and protections must be carried out for each machine;
c) The manufacturer / supplier must provide all certifications and documentation required by the legislation of the country or region where the machine will be installed.

7.8 Requirements for training

a) Employees that work in operation, maintenance, adjustments, and other activities on machines must be trained on this RAC;
b) Machine risk assessment specialists must be trained on the HRN methodology;
c) Employees working on projects and machine acquisition must be trained on the requirements of this RAC.

7.9 Roles and responsibilities

7.9.1 Directors:

a) Must formally assign persons responsible for carrying out risk assessments of new, existing and modified machines;
b) Must formally assign one or more persons responsible for:
I. Creating and managing local procedures as described in this RAC;
II. Creating and managing local training programs;
III. Creating and managing a program to verify the effectiveness of implementing the requirements described in this document;
V. Providing and managing the necessary resources to implement this RAC.

7.9.2 Managers:

a) Must approve local procedures as described in this RAC.

7.9.3 Employees and contractors involved in machinery activities:

a) Must comply with the requirements established in this document and in local procedures;
b) Must activate the local help chain, in case any identified irregularity cannot be resolved.

8. RAC 08: ACTIVITIES ON THE GROUND

8.1 Foreword

In past years, Vale's operations have experienced significant ground failures related to the instability of **geotechnical structures**, like slopes, underground openings, and uncontrolled water flows. Some important contributing factors associated with these events have been:

a) Geometry incompatible with design;

b) Increase of saturation level (presence of water);

c) Inappropriate execution of the activity;

d) Use of inappropriate equipment type and/or size;

e) Lack and/or failure of the support/shoring system;

f) Lack and/or failure of protective barriers;

g) Lack and/or failure of area isolation;

h) Compromised or limited visibility;

i) Operator fatigue;

j) Failure in perceiving risks.

8.2 Purpose

Establish minimum requirements for the safe execution of activities carried out directly or in the area of influence of geotechnical assets at Vale, aiming to eliminate or control the risk of injuries or fatalities.

8.3 Application

The requirements of RAC 08 apply to all business units and operations managed by Vale, including new acquisitions. Its scope is associated with **activities direct or within the radius of influence** of all geotechnical assets subjected to mass movements that have critical potential, like natural or excavated slopes, embankments (compacted or not), waste and/or tailings dumps, stockpiles (fine materials, pellets, etc), as well as excavations in trenches and underground openings.

8.4 Exceptions

The requirements of RAC 08 do not apply to excavations under 1.25 m[29] and do not apply to the management of confined spaces.

8.5 Important definitions

- **Asset:** A Vale-managed site **or constructed or dynamic geotechnical structures** that could be an exploration target, capital project, active operation, under care and maintenance, or under post closure management.
- **Asset life cycle:** The components of the life cycle of an asset include: 1) the conception and planning phase, 2) the design phase, 3) the initial construction phase, 4) the operations and construction phase in progress, 5) the temporary interruption of operations, and 6) the closure and post closure phases.
- **Checklist:** A verification list that must be completed prior to work which relates to risk identification, including a Safe Work Permit, Task Risk Assessment, or equivalent normative document.
- **Design:** The method, construction sequence/stages, and geometry of an asset to ensure a safe, efficient, and effective excavation. **Mine plan** and **work instruction** are also synonymous with this term.

[29] However, for excavations below 1.25 m, check whether there are buried structures in the area before the activity is carried out.

- **Excavation:** Removing soil or rock following design guidelines or another type of record or formal plan.
- **Experienced Individual:** An individual who is appropriately trained to complete the activity in question.
- **Failure:** Any unplanned movement of soil or rock that has a detrimental impact on the business.
- **Qualified individual:** A person who:
  - Has a degree in mine engineering, geology, or a related earth science, specializing in geotechnics and/or civil engineering.
  - Has an appropriate professional registration, when applicable.
  - Is a Senior Geotechnical Practitioner (or a rank above this) of Vale or an external consultant/contractor who has a working knowledge of the operation of interest.
  - A Qualified Individual must be specified in management plans and must have experience gained at an underground or surface mining operation, ground engineering company or geotechnical consultancy providing engineered underground designs, engineered slope designs, or hazard assessment services.
- **Secured ground:** Ground that has been scaled and/or reinforced to prevent failures that could result in injuries to personnel.
- **Slope:** Any inclined surface made up of soil or rock. It may be:
  - Natural: formed by nature with no human interference.
  - Engineered: slope that underwent human interference through cuts or fills:
  - Cut: An inclined surface resulting from excavation activities including roads and mining slopes).
  - Fill: An inclined surface resulting from material fill/stacking activities.
- **Trigger action response plan (TARP):** Defined thresholds that, when exceeded, trigger specific actions to mitigate risks.

8.6 Requirements for installations and equipment

8.6.1 General requirements for tools, equipment, and devices

a) Tools used for manual excavation must be appropriate for the activity to be performed, in good working condition, and used as per the relevant safe work procedure for the activity;

b) The type and size of equipment for excavation activities must be appropriate for the type of activity to be carried out, in good working condition, used as per the relevant safe work procedure for the activity, and able to reduce the risks to an operator to as low as reasonably practical;

c) Lighting must be sufficient to allow work to be carried out safely and in accordance with the relevant safe work procedure;

d) Devices necessary to manage surface water **and/or** groundwater must be implemented and maintained according to designs.

8.6.2 General requirements for barricades, signage, and protection barriers

a) Access to an isolated area that has experienced a ground failure should be controlled as per the relevant procedure **and/or risk analysis**, and should only be granted to people and equipment directly involved in remediation or repair work, **conditional on release by a qualified professional;**

b) Area isolation with barricades or physical barriers (**example: pedestals, cones, spikes**) and signage must be used, **with distance defined in procedure, project or risk assessment**. It is forbidden to use plastic tape to isolate an area;

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c) The type, size and location of protection barriers must be installed according to designs and commensurate with the potential hazard to ensure any ground failure is contained;

d) The types of barricades[30] and signage used to isolate hazards must be stipulated in safe work procedures and must be in line with local legislation and Vale standards.

[30] The following types of barricades are considered: trestles, cones, chains. Barricades alone can not be used as barriers for protection purposes.

8.7 Requirements for procedures

8.7.1 General requirements for monitoring

a) A process for performance monitoring and inspection **of assets** must be developed and implemented via safe work procedures. The process must define:
   I. Instrumentation requirements, including the type, number, calibration needs, and maintenance routines;
   II. Frequency and responsibility for inspection, monitoring and evaluation;
   III. Guarantee and quality control requirements for support elements, excavation development, sequencing, and mining rate;
   IV. Response actions regarding scenarios when specified limits have been exceeded;
   V. Signage and restrictive actions for all geotechnical risk areas.

b) An alert and communication system associated with slope and/or underground opening behavior monitoring must be in place as per a design and a Trigger Action Response Plan (TARP) must be in place, **in accordance with applicable legislation and regulations, including a reentry protocol;**

c) If ground failure is identified, work must stop and an assessment by an experienced or Qualified Individual must be completed, as defined in local procedure requirements. Resumption of work in the area can only occur once specified controls have been implemented;

d) A conformance measurement process must be developed and implemented for slopes **and/or** underground openings. The results of such a process must be communicated to all those directly involved in the activity;

e) The performance and conformance data of slopes **and/or** underground openings must be routinely reconciled with the design, which must be updated as required;

f) Duly experienced individuals must be appointed to carry out performance and conformance measurements;

g) All geotechnical data must be stored in an accessible and auditable database;

h) A work area inspection includes the completion of a hazard checklist, which must be completed by an experienced individual directly involved in the activity prior to commencing work. This checklist must:
   I. Have fields to assist with the identification of geotechnical hazards;
   II. The definition of observations which prevent work from commencing;
   III. be stored in a readily accessible location according to a safe work procedure.

In case of identification of an unsafe condition by the person performing the activity, follow these guidelines:
   I. the activity must be stopped, people and equipment should move to a safe location, and the person in charge/supervisor must be called;
   II. If in doubt regarding the measures to block/mitigate the risk, the person in charge/supervisor must inform the geotechnical team;
   III. A geotechnical engineer must complete an assessment of the area and define controls to be implemented before work can commence.

Note: The use of remote-controlled equipment must be considered to reduce the risk to acceptable levels.

i) For assets that require a 24-hour monitoring system (defined in the project or in risk analysis), a Contingency Plan must be drawn up, which must be activated in case of system unavailability.

j) Monitoring systems must have the degree of reliability and availability determined in accordance with risk analysis.

8.7.2 General requirements for management plans, change management and emergency planning:

a) Each asset must develop a management plan which is reviewed and approved by a Qualified Individual, as determined by local legislation, local procedures, risk assessment or a significant geotechnical incident. This plan must have:
   I. Actions and accountabilities for managing slope and underground opening geotechnical risks, including effective communication and verification of geotechnical risk management strategies;
   II. Actions and accountabilities to set design and executive methodology specifications;
   III. Engineered slopes and underground openings must be based on adequate geological, geotechnical and hydrogeological data;
   IV. Plans and accountabilities must be determined governing the way engineered slopes and underground openings are designed and constructed;
   V. Plans and accountabilities must be determined governing the way natural slopes and underground openings are assessed and managed;
   VI. Standards and accountabilities must be determined governing the way an Experienced or Qualified Individual must assess and validate mine designs so as to guide the team towards actions that must be implemented to mitigate geotechnical risks;
   VII. Standards and accountabilities must be determined governing the way engineered slope and underground opening designs must meet, or exceed, specified minimum design acceptance criteria using industry accepted design techniques;
   VIII. Standards and accountabilities must be determined governing the way experienced individuals directly involved in an activity, or their supervisors, must check work area information with regards to the main risks already mapped, the history of previous ground failures, and uncontrolled water flows;
   IX. Standards and accountabilities must be determined governing the way an experienced or Qualified Individual must be responsible for natural slope and underground opening geotechnical hazard management strategies as well as engineered slope and underground opening designs;
   X. A safe work procedure must be in place and adhered to governing the detonation of explosives and the re-entry of areas where explosives have been detonated;
   XI. Standards and accountabilities must be determined governing the way all forms of ground failure will be investigated, addressed and recorded;
   XII. Work area information must be provided with regard to the main risks already mapped, the history of previous ground failures, and uncontrolled water flows will be checked;
   XIII. If geotechnical conditions encountered in the field are significantly different than assumptions used for designs, standards and accountabilities must be determined governing the way the geotechnical team will be notified to assess if designs need to change and their responsibilities to document and notify relevant personnel of changes to existing ground conditions and controls.

b) Management plans for specific geotechnical material unwanted events such as rockburst, inundation of liquids, in-rush of solids, or airblast should be developed if local legislation demands, or if deemed necessary by a risk assessment;

c) A change management process must be implemented and used in case of major changes and documented in a procedure. This procedure must also specify clearly what constitutes a major change to designs and geometries;

d) An Emergency Response Plan must be drawn up, based on PNR-000066 - Emergency Response Management, for the planned activities and/or scenarios mapped for geotechnical assets that may pose a danger to people;

e) Clear and visible signs must be in place which demarcate egress routes and muster points in case of an emergency. These routes and muster points must be visible on plans accessible to personnel;

f) The maintenance plan must be systematic for auxiliary control systems of geotechnical assets, not limited to the drainage system, containment barriers and monitoring systems.

8.7.3 Requirements for carrying out activities:

a) An activity risk analysis must be carried out in advance, for activities within a geotechnical risk area and/or with direct interference and potential instability in the asset. The risks in the area must be reassessed after the occurrence of potential events (examples: bad weather, deformations in the terrain or rock collapse); P!

b) All activities close to and/or that interfere with the asset, as well as parallel activities, which may impact its integrity/conformation must be planned, with an approved design or project, as well as control measures for the steps sized in the activity; P!

c) **The progress of the equipment must be controlled by georeferencing (onboard or by physical marking in the field).**

8.7.3.1 Requirements prior to the beginning of the activity in surface:

a) For civil earthworks, there must be a check completed for buried utilities. The person in charge of the activity must consult the relevant drawings related to buried utilities in the area. In case of possible interference with a utility, a specific assessment of the area must be carried out using suitable equipment. A report on the assessment must be written and part of a checklist for identification of risks and controls;

b) Phreatic level drawdown targets as defined in designs must be adhered to;

c) Physical slope design markers in the field must be clear and in compliance with designs; alternatively, accredited CAD tools that have been tested can be used on equipment;

d) Excavations to a depth of 1.25 meters or more must be designed by a Qualified Individual, and have support, shoring system, or protection barrier in place or sloping/benching carried out, as well as a means of egress. Excavation work can only commence once the support, shoring system, and/or protection barrier is in place;

e) The piles must meet the angle of repose/conformation and the height limit determined in the project or engineering/geotechnical analysis to guarantee their stability, according to the characteristics of the material handled, minimally considering lithology, compaction, humidity and granulometry;

f) For product stack/pile, the area of influence may vary according to the type of material, where variations must be anticipated and controls established for the operation;

Note 1: The determined times must foresee variations in dry and rainy periods;

Note 2: Environmental control systems must be monitored so as not to impact stability;

Note 3: Saturation control (flooded base) must be carried out prior to stacking.

8.7.3.2 Requirements to execute the activity in surface

a) Deployment of mine and waste disposal plans must comply with safe work procedures and technical instructions.

8.7.4 Underground specific activities

8.7.4.1 Requirements prior to the beginning of the activity

a) Ground support designs must consider failure mechanisms, the purpose of the support, its service life, and opening geometries and induced loads it must address over its service life.

8.7.4.2 Requirements to carry out the activity

a) No personnel must work beneath ground, or at a face, that has been inadequately secured;

b) Safe work procedures must be developed and adhered to which specify:

I. The persons authorized to install ground support in accordance with approved designs and the training required to prepare them;

II. The tools and equipment required to install monitor and inspect ground support, which cater to all sizes of excavation encountered in the mine;

III. The tools and equipment required for scaling that cater to all sizes of excavation encountered in the mine and which will allow loose material to be removed without exposing persons performing the work to injury;

IV. The persons authorized to scale and the training required to prepare them;

V. All lateral and vertical development methodologies, including perimeter control;

VI. Breakthrough of lateral and vertical development.

8.8 Requirements for training

Employees who carry out activities close to or **in geotechnical assets (within the scope of this RAC)** must be:

a) Trained in RAC 08 local and global training, including its updates, according to Vale's Qualification Guidelines.

Operations and projects must consider the minimum requirements presented in this RAC for the development of specific operational procedures for each project/Mine, adapted to the reality of the activities and local legislation, as well as defining a training program for all of them.

8.9 Roles and responsibilities

The responsibility to follow and enforce these requirements is inherent to all employees of Vale's units who perform activities related to the management of **geotechnical assets**, including contractors and supervisors. See below a description of the relevant roles and responsibilities:

8.9.1 Director:

a) To be qualified in the global RAC 08 training;

b) To provide resources (financial, team, logistics, equipment, etc.) to guarantee the appropriate execution of activities.

8.9.2 Area management must be:

a) Qualified in the global RAC 08 training;

b) Responsible for making sure that controls are effectively implemented in the area under its responsibility;

c) Be responsible for technical support and monitoring compliance and application of controls defined.

8.9.3 Health, Safety & Environment (HSE) professionals must be:

a) Qualified in RAC 08 (global and local training);

b) Responsible for technical support and monitoring compliance and application of controls defined.

8.9.4 The person in charge of the activity / supervisor[31] must:

a) Be qualified in RAC 08 (global and local training);

b) Be responsible for following up and checking the quality of the way the risk assessment process is carried out regarding activities that will be executed;

c) Ensure changes regarding activity status between shifts, technical and operational teams are communicated;

d) Check eventual anomalies reported or registered, using a checklist;

e) Ensure implementation and ensure compliance with relevant Critical Activity Requirements;

f) Ensure those involved in carrying out critical activities are qualified;

g) Ensure there is flow management regarding activities to assess risk perception and follow up activities on slopes;

[31] The person responsible for the activity can be contract supervisor and/or third-party agent.

h) Interrupt or suspend any activity that does not comply with the requirements of this RAC and/or that may compromise the objective of preserving physical integrity.

8.9.5 Professionals directly involved must:

a) Be qualified in RAC 08 (global and local training);

b) When applicable, develop the checklist prior to beginning activities;

c) Be responsible for making sure that controls defined are effectively implemented in the area under their responsibility;

d) Attach the interference assessment report, when applicable;

e) Isolate the work area and lock out hazardous power sources, when applicable;

f) Ensure that only appropriate equipment and tools are used;

g) Interrupt or suspend any activity that fails to meet requirements in this RAC and/or that may compromise the objective of preserving physical integrity.

9. RAC-09 – EXPLOSIVES:

9.1 Foreword

Some of the critical accidents at Vale have occurred during explosives handling and transport. The main contributing factors associated with these incidents were:

a) Inadequate handling and transport of explosives and accessories causing impacts and activation;

b) Exposure of the explosives to heat;

c) Exposure of the explosives to atmospheric and electrical energy;

d) Lack of knowledge about the products;

e) Inadequate isolation system in the area before blasting;

f) Proximity of the worker to sources of ignition and blasting;

g) Inadequate storage of explosives;

h) Activation of explosives by static energy;

i) Failure in the execution of the blast plan.

9.2 Purpose

Establish minimum requirements for the safe execution of critical activities linked to the transportation, storage, manufacturing, handling, loading, detonation, and disposal of explosives, including safe practices and distancing, aiming to eliminate or control the risk of injuries or fatalities.

9.3 Application

Critical activities related to transporting, storing, manufacturing, handling, loading and blasting explosives in open pit and underground mines and construction projects (to open roads and tunnels and remove obstacles).

9.4 Exceptions

RAC 09 does not cover handling of explosives related to demolition of structures (buildings, bridges), and external transport of explosives by **supplier (under CIF contract type).**

9.5 Important definitions

- **ANFO** – Ammonium nitrate fuel oil.
- **Airblast**: An airborne shock wave resulting from the detonation of explosives.
- **Blasting influence area**: The area where the effects of the blasting can be felt or cause damage by vibration, airblast, fly rock, fumes, and dust.
- **Blaster**: The person responsible for handling explosives and accessories, who is responsible for organizing, distributing, and connecting the initiation system, isolating the area, and supervising the rock blasting.
- **Blasting exclusion zone - BEZ (area isolation):** The area determined by a risk assessment process in which to assure that all expected / foreseen effects of the blasting are kept within a controlled area. The blasting

exclusion zone can be subdivided into subzones, with an inner sector defined as an equipment exclusion area and a wider area defined as a people exclusion area.

- **Bench face**: Exposed surface of the rock where the mining work is progressing.
- **Competent person**: An experienced professional duly certified to handle explosives.
- **Deck:** Material placed in the borehole to separate explosive charges, such as an intermediate stem, made of inert material (such as gravel) or an air bag, used for the blasting control.
- **Electronic detonator:** A device formed by a fuse coupled to an electronic circuit that allows delays to be programmed (activation timed). It is activated by a set of programming and detonation equipment specific for this purpose.
- **Fly rock**: A condition in which a rock fragment is propelled beyond defined limits of the blasting safety area.
- **Free face**: The face of the bench without rock from the previous blasting.
- **Misfire**: A charge, or part of an explosive charge, which for some reason did not blast as planned.
- **Magazine**: A building intended to store explosives and their accessories, ammunition or other controlled products. It can be permanent or temporary.
- **Open flame**: A mixture of incandescent gases which emit energy, also called open flame, flame or fire.
- **Primer**: A set of explosives, basically composed of a booster and a detonator or explosive sensitive to the detonator and a detonator used to start the main column charged with emulsion or ANFO.
- **Stemming**: Inert material used to confine gasses generated during explosives detonation.

9.6 Requirements for installations equipment

a) The explosives storage and preparation areas must comply with the provisions in the local legislation, based on a formal project prepared by a competent professional;
b) The tools and accessories used in the activities **in direct contact with explosives** must be anti-spark;
c) There must be informative and warning signs in the internal and external areas of the magazine areas (prohibition to use cell phones, metal tools, lighters, matches, etc.);
d) Permanent or temporary explosive storage areas must be locked and segregated from other vulnerable areas (electrical and mechanical installations, evacuation areas, fuel storage areas, etc.).;
e) Vehicles for transporting explosives and accessories must be used exclusively for this purpose, must comply with local legislation and the requirements of CARs 02 and 03, and must be provided with:
   I. Static energy dissipation devices;
   II. Specific signaling;
   III. Flame arresting device in discharge pipes (underground mine and open pit). For open pit mines, discharge pipe outlets positioned upwards can be applied in place of the flame arrester.
f) The blasting system must comply with the specifications below:
   I. **Open-pit mines** must use an electronic fuse in 100% of the blast plan, in the development and production phases. If identifies the need to use 2 (two) detonators per hole, the second detonator must be electronic or conventional (non-electric), according with the local risk analysis;
   II. **Underground mines** must use an electronic fuse in 100% of the blast plan in the production phase. If identifies the need to use 2 (two) detonators per hole, the second detonator must be electronic or conventional (non-electric), according with the local risk analysis. In the development phase or mining methodology chambers and pillars, the activation must be remote and may use a non-electric system;
   III. The electronic fuse must have extra protection against electromagnetic pulse, and proof by the manufacturer through a certificate.

NOTE 1: If allowed by local legislation, pre-splitting can be performed using a detonating cord, with electronic initiation.
NOTE 2: It is forbidden to use a cap fuse (conventional) as an explosive charge initiator.

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NOTE 3: **The use of the non-electric initiation system introduces new risks to the process, and precautions must be taken against the "snap, slap and shoot" phenomenon, that is, avoiding cutting, friction, impact, traction, or tension on the cable. initiation system by potential detonator initiation.**

g) **The Emergency Response Plan (ERP) must be developed in accordance with PNR-000066 – Emergency Response Management and the supplier's ERP (when applicable);**

h) **Drilling must be georeferenced (designed and executed) and have established management parameters (QA/QC – Quality Assurance and Quality Control).**

9.7 Requirements for procedures

9.7.1 General requirements procedures:

a) The safety guidelines of the explosives and accessory manufacturers stated in the MSDS must be followed, including:
   I. **segregation according to material compatibility group and according to PNR 000124 - Hazardous Material Handling - Explosives - Storage;**
   II. **use of an anti-static protection device at the entrance to the magazine.**

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b) It is forbidden to handle explosives and accessories on surface **during red alert** and storms when the possibility and/or occurrence of electrical discharge (lightning strike) exists;

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c) To perform hot work near the explosives storage areas (deposit and factory), the following must be applied PNR-000031 Safe Work Permit (SWP) Guideline;

d) It is prohibited to smoke, use an open flame, and carry lighters, tools or material that may produce sparks in places where explosives are stored or handled, **adopting a minimum distance of 20 m;**

e) It is prohibited to use electronic devices that are not intrinsically safe in places where explosives are stored or handled and that are classified as a restricted or flammable area;

f) It must be assured that information about and notice and rescheduling of blasting times will reach all people involved, internally and externally;

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g) **When handling explosives, implement measures to protect devices from excess Friction, Impact, Shock and Heat (FISH), for example: cutting detonating cord with a single blade, positioning explosives spaced apart area with risk of block falling, insert the primer directly into the hole as soon as priming has been carried out, among others;**

h) Excess explosives and accessories must be returned to the magazine;

i) Explosives that are in an impaired state of conservation, defective, or non-conforming, including explosives from misfire, must be identified, segregated and destroyed, according to regulations in force and manufacturer's instructions, **and specific controls for carrying out disposal are established in procedures;**

P!

j) **Every explosive to be used must be previously dimensioned in a blast plan**, which must establish measures to protect people and nearby communities, including distance and protective barriers, considering:
   a) lithological variations in the area designated for blasting;
   b) geotechnical condition;
   c) type of blasting.

Note 1: The blast plan must be readjusted depending on the presence of new conditions that affect the geometry, load ratio or expected confinement.

k) **During the red alert, the potential rock throwing area must be isolated (due to the risk of accidental triggering of the explosive), determined through risk analysis;**

l) **The maintenance plan for assets used in emulsion or ANFO plant, deposits and equipment used for handling material for rock blasting must contain minimum guidelines to be carried out the activity, such as: definition of type of tool, criteria for decontaminating equipment, method of executing the task, among others;**

m) Explosive packaging must be destroyed by combustion, in a safe place that does not pose risks to other parallel activities. Boxes must be empty and free of materials.

9.7.2 Storage procedures:

a) Explosives and accessories must be kept in their original packaging;

b) A system must be implemented to control the inventory of products received and dispatched. Inventory management must use the "first in, first out" principle.

9.7.3 Procedures for transporting accessories and explosives in vehicles:

a) In the loading and unloading activity, explosives and accessories must be placed directly on the transport vehicles positioned in previously marked locations;

b) The vehicles must be grounded while **bulk explosives** (except when loading blasting holes),are being loaded and unloaded;

c) Transshipping explosives and accessories to other vehicles outside the magazine is forbidden, except in emergency (vehicle breakdown, sticking, rain, etc.);

d) If accessories and explosives are transported simultaneously, a (shielded) compartmentalized boxes must be used to prevent contact between the accessories and explosives;

e) A rotogram (risk analysis) must be used for the external transport of explosives and oxidizers.

Note 3: If Vale needs to carry out external transport of explosives, comply with PNR-000124 – Hazardous Material Handling - Explosives - Storage and local legislation.

9.7.4 Blasting handling and preparation:

9.7.4.1 General requirements:

a) Signaling must be applied at the entrance of the mine with boards containing the blaster's (the person responsible for the blasting) radio band and telephone number, blasting times and locations of the area to be blasted;

b) The person responsible for the activities must assure that all people have been evacuated from the area and the vicinity that can be affected before releasing the area for blasting;

c) An audible alarm system must be activated before detonation, according to PNR-000060 - Hazardous Material Handling - Explosives - Handling and Disposal;

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d) The explosives loading area must be blocked, respecting the safety distance defined in risk analysis and local procedure. Where technology is available, perform electronic blocking of autonomous mobile equipment (trucks, etc.).

9.7.4.2 Open-pit blast:

a) A georeferenced system must be used (GPS, maps, etc.) to encircle these areas;

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b) A physical block must be carried out in the Blasting Exclusion Zone. Where technology is available, must perform:

I. electronic blocking of autonomous mobile equipment (trucks, etc.);

II. implement engineering control to certify the exclusion of people from the isolation area (example: drone with heat sensor, tracker);

III. condition the Blasting Control Box (or Blasting Control Box) to activate only outside the already isolated area.

9.7.4.3 Underground blast:

a) To carry out the detonation, personnel must be evacuated **from the mine or tunnel or from the detonation influence area (BEZ)** (where there may be gases, dust, material projections, or seismic vibration that may affect the stability of the landform);

b) An effective process to control the entry and exit of the area of influence of the detonation (BEZ) must be available (example: the use of label frames).

9.7.5 Blast plan:

9.7.5.1 Content for blast plan:

A blast plan and an executed blast plan must be established, including at least:

a) Blast Plan objectives - Type of blasting;

b) identification of the blast plan (polygon, date, time, blaster and signature of the technician in charge);

c) excavation area, rock volume;

d) characterization of the material to be blasted;

e) diameter(s) of hole(s);

f) bench height;

g) determination of the perforation mesh (type of mesh, distance, spacing, number of lines);

h) depth and depth of holes, average, minimum and maximum depth;

i) number of holes, perforated footage, extra holes;

j) under-drilling;

k) buffer determination:
   I. depth;
   II. type;
   III. plugs.

l) use of decks (type, if you are going to use it);

m) explosives (types) and properties (density);

n) total explosive charge (kg);

o) accessories;

p) load ratio (specific load) kg / m3 and / or kg / t;

q) timing (layout and movement of the rock mass);

r) pre-splitting;.

s) relief line;

t) distance to the nearest structure to be protected;

u) estimation of particle velocity (peak) and acoustic pressure;

v) rock projection estimate;

w) calculation of SDoB (dimensioned burial depth) - energy control scale;

x) radius of the safety zone (plan with definition of the safety zone for people and machines);

y) layout (plan) of the drilling grid;

z) hole profiles (terms) with primer positioning, loads, decks and buffer.

9.7.5.2 Requirements to return after blasting:

Return to the blasting site must occur only after the fumes and dust have dissipated and misfire has been verified and authorized by the person responsible for the activities as below:

a) Open pit and underground mines: The minimum time for return after blasting must be established.

a) Underground mines: The minimum time for return after blasting and atmospheric monitoring must be established.

9.7.6 Misfire:

a) In case of suspicion or finding of a misfire, the PGS-00004640 – Handling and recovery of holes with failure in the electronic detonator must be complied with.

b) In case of a failed fire initiation, wait at least 30 minutes before to take any action, in addition to checking the characteristics of each location.

c) If a misfire in the muckpile is detected or suspected after the blasting area is released, the work must be stopped immediately, the area must be evacuated, and the situation must be reported to the person responsible for the activities who will adopt the appropriate measures to control the risk.

NOTE 1: If an initiation system other than the electronic system is used, the equipment used to treat misfires must preferably be unmanned.

9.8 Requirements for training

a) The employees who carry out activities for manufacturing, transporting, storing, handling, charging, blasting explosives **and maintenance of process equipment** must be trained in this RAC.

b) The specialists in manufacturing, **maintenance**, handling, and blasting explosives (e.g., the Blaster) must be trained in accordance with local legislation.

c) The qualification guideline in PNR-000069 RAC must be met.

9.9 Roles and responsibilities

9.9.1 Director:

a) Formally designate one or more people to be responsible for developing and maintaining the following processes/procedures/controls:
I. A policy of following local procedures as described in this RAC,
II. A training and evaluation program for employees involved in the process of manufacturing, transporting, storing, handling, charging and blasting explosives,
III. A program for verifying the effectiveness of implementing the requirements described in this document,
IV. A process to provide the necessary resources for implementing this RAC.

9.9.2 Management:

a) Approve local procedures as described in this RAC.
b) Formally approve the employees authorized to carry out activities with explosives and accessories.

9.9.3 Employees and contractors involved in activities with explosives and accessories must:

a) Comply with the requirements set forth in this document and local procedures, and
b) Call the local help chain if any identified irregularity cannot be resolved.

RAC-10 – WORKING WITH ELECTRICITY:

10.1 Foreword

Several serious and/or potentially serious events involving the exposure of people to electrical hazards occurred in recent years at Vale. The main factors associated to these events were:

a) Work within the Electrical Shock Hazard Distance and/or within the Electrical Arc Flash Hazard Distance without the appropriate barriers/ protections;

b) Lack or deficiency in systems, devices or identification of electrical protection;

c) Lack or deficiency in Personal Protective Equipment;

d) Lack or deficiency in the proven voltage absence test;

e) Lack or deficiency in the identification of equipment/components;

f) Lack or deficiency of technical documentation (single line diagrams, project specifications, etc.);

g) Lack of criteria to select measuring instruments to perform electrical tests;

h) Use of inadequate tools/ equipment;

i) Lack or deficiency of procedures to perform electrical work;

j) Not complying with procedures to perform electrical work;

k) Lack or deficiency of training of people performing electrical work activities;

l) Lack or deficiency of professional qualification of the personnel who perform the electrical work activities;

m) Failure to lockout electrical energy (RAC04 – Lockout, Identification and Zero Energy);

n) Failure to correctly apply the clearance distance for the circulation of mobile equipment and equipment for lifting load and people in the proximity of overhead energized electrical lines (RAC01 – Working at Height, RAC03 – Mobile Equipment Operation and RAC05 – Lifting of Loads);

o) Lack or deficiency of protection barriers to avoid the contact of metallic structures with energized surfaces;

p) Failure or deficiency in the protective measures that prevent the re-energization of lines, equipment and components after an automatic trip.

10.2 Purpose

To establish Safety and Health requirements to eliminate, control and mitigate the hazards of fatalities, injuries or incidents involving electrical work.

10.3 Application

All works in electrical installations containing equipment/systems with voltages above 50 V AC (Alternating Current) or 120 V DC (Direct Current).

The requirements in this RAC apply to the following works, among others:

a) Preventive or Corrective maintenance or electrical switching in electrical switchgear, connection and lighting panels, automation panels, switchgear and distribution panels, junction boxes, Cubicles and Cabinets, frequency Inverters and generators;

b) Tests in industrial outlets;

c) Sensitive and predictive inspections in panels or equipment in the field;

d) Preventative maintenance in rectifiers, chargers and battery banks;

e) Preventative or corrective maintenance in Plug and Switch System (PASS) control circuits;

f) Preventative or corrective maintenance in control circuits of oil or dry transformers;

g) Opening and Closing disconnecting switches.

10.4 Exceptions

The requirements in this RAC do not apply to the following works:

a) Manual positioning of excavator electrical power cables (requirements in RAC 03 –Mobile Equipment Operation);

b) Maintenance and use of electric power driven tools (drillers, sanders, saws, chainsaws, grinders, etc.);

c) Maintenance of laboratory equipment (chromatographs, analyzers, ovens, etc.);

d) Maintenance in office machines (computers, copying machines, TV sets, vending machines, etc.);

e) Work near electrical equipment or installations, such as: installation of telephone or data wiring, grass and tree cutting activities, cleaning and housekeeping inside electrical rooms and substations, etc.;

f) Operation or circulation of mobile/lifting equipment near overhead energized electrical lines (requirements in RACs 01 Work at Height, 03 –Mobile Equipment Operation and 05 – Lifting of loads);

g) Excavation work on the proximity of underground electrical lines;

h) Work performed by the local power distribution company.

i) On-off switching of low voltage electrical circuits with materials and electrical equipment in perfect condition, suitable for operation and which incident energy is less than 1.2 cal/cm^2.

10.5 Important Definitions

- **Arc Flash, Working Distance, Incident Energy, Arc Flash Boundary, Electrical Arc Flash Hazard Distance, Electrical Shock Hazard Distance –** definitions are available at PNR-000051.

- **Damp location** – locations protected from weather and not subject to saturation with water and other liquids but subject to moderate degrees of moisture.

- **De-energized Electrical Work -** Work performed on an equipment or component that is part of the electrical system which is disconnected from any source that may generate a difference in potential and electrical charge, with no potential difference in relation to the grounding system.

- **Diagnostic work –** work that does not require any physical change to the equipment/component, such as readings, measurements, and tests.

- **Electric Power Systems** – Set of installations and equipment aimed to generate, transmit and distribute electrical power, including the measurement device spot.

- **Electrical equipment and installations** – sets of equipment and components described in the objective and application of PNR-000053 – Electrical Systems – General.

- **Electrical Switching** – manual or automatic change in the electrical settings or a circuit, by means of an adequate device designed for this purpose.

- **Energized Electrical Work -** Work performed on an equipment or component that is part of the electrical system which is connected to any source that may generate a potential difference or electrical charge.

- **Energized part** – energized conductive equipment.

- **High Voltage, Low Voltage, single line diagram** (item 6.4.1 – Operation – Item i) – definitions are available at PNR-000053.

- **Hazardous classified areas –** definition is available at PNR-000027.

- **Live line work or Hotline maintenance: Work carried out in such a way that the person has direct contact with the energized parts, remaining at the same potential as them, using a set of conductive clothing connected to the energized parts at all times.**

- **Personal Protection Safety Barriers** – means used between the energy source and the worker to prevent the contact with electrical energy in case it is released and/or to interrupt its flow when it is released. Examples of safety barriers for electrical energy include arc flash and electrical shock PPEs, blankets and matting for electrical shock protection, among others.

- **Repair work –** work that requires physical modification of the equipment/component, such as tightening connections, cleaning, removing, or replacing components**.**

- **Temporary Electrical Grounding** – definition is available at PGS-004901.

- **Wet location** – installations underground or in concrete slabs or masonry in direct contact with the earth or locations subject to saturation with water or other liquids. Installations and locations not protected from weather.

10.6 Requirements for installations and equipment

The electrical equipment and installations must have, as a minimum:

a) Identification of incident energy with label as per **item 6.1.1.** of PNR-000051; P!

b) Grounding/Lightning Protection as per **items 6.2.2. and 6.2.3** of PNR-000052; P!

c) Protection Systems for Electrical Systems as per **item 6.4**. of PNR-000080; P!

d) **Updated** one line electrical diagrams as per **Table 3 of item 6.1.3** of PNR-000053; P!

e) Residual Current Devices (RCD) **or similar in the spots where** there is the risk of electrocution, as per local legislation, technical standards and the project specifications; P!

f) Appropriate protection that prevents inadvertent contact with energized parts; P!

g) Safety signs complying with the local legislation.

10.7 Requirements for procedures

10.7.1 General Procedures

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a) The electrical work where the worker enters the Electrical Arc Flash Hazard Distance or where there is interaction of the worker with the equipment, conductors, or parts of circuits, with the probability of injuries to the worker due to electrical arc flash or electrical shock, must be de-energized by means of the following steps, except in the situations covered in item 10. 7.3:
   I. sectioning;
   II. lockout (impediment to re-energize);
   III. test of absence of voltage at the intervention point;
   IV. temporary grounding installation with equipotentialization of the circuit conductors at the intervention point;
   V. protection of the energized parts present at the Electrical Arc Flash Hazard Distance Zone, when applicable;
   VI. installation of signs of impediment to re-energize.

b) It is prohibited to perform live line work or hotline maintenance in high voltage (above 1kV), including works in power transmission lines with energized circuits.

c) It is prohibited to perform any electrical work on high voltage power circuits, including cleaning, which requires entry into cubicle compartments, without the complete de-energization of all inlet and outlet points of the panel that could result in electrocution and/or exposure the workers to incident energy levels capable of causing burns and/or more serious consequences.

d) The workers must be authorized to perform electrical work as per local legislation. The authorization must be documented in the work contract records of the company.

e) It is prohibited to perform any electrical work without specific formal authorization for the activity.

f) It is prohibited to perform high voltage energized electrical work individually.

g) Local criteria must be defined to establish the situations which require that low voltage energized electrical work must not be performed individually.

h) Study of Electric Arc Incident Energy must be prepared and implemented for electrical equipment as established in the item 6.1.1.1 of the PNR000051.

i) The work on energized panels with incident energy above 40 cal/cm^2 is prohibited as per PNR-000051.

j) The Personal Protective Equipment must be defined in local procedures and compatible with the voltage and incident energy levels of the electrical installation, with the use of PPE with minimum value of 10 cal/cm^2 being mandatory, as per PNR-000051.

k) For works inside **or that may enter** the Electrical Arc Flash Hazard Distance (EAFHD) a personal voltage detector type “helmet” or “wrist” (or similar device) compatible with the involved voltages must be used as an individual protective measure to alert against a non-intentional proximity of parts of the body to energized surfaces.

l) The use of a personal voltage detector to confirm the absence of voltage is prohibited. To confirm the absence of voltage, it is mandatory to use specific, appropriate and previously tested voltage detection instruments to verify the absence of voltage appropriate to the voltage levels of the circuit or work point.

m) The Personal Protective Equipment – PPE, the equipment, instruments, and tools to be used in electrical work must be inspected before each use **and tested complying with the manufacturer’s instructions and local legislation.**

n) The use of personal ornaments (watches, rings, earrings, necklaces, among others) is prohibited while performing electrical work. This requirement does not apply to the use of the personal voltage detector, which is an individual protective measure to alert against a non-intentional proximity of parts of the body to energized surfaces.

o) The Personal Protective Equipment and the collective protections used as barriers (examples: rubber gloves, blankets, matting, temporary grounding systems, etc.) and the tools used in high voltage electrical work must be periodically tested complying with the manufacturers' instructions and local legislation.

p) The measuring equipment / test meters used to perform electrical work must be inspected, calibrated and tested complying with the manufacturers' instructions and local legislation.

q) The reset of electrical devices after an automatic trip must comply with local criteria including the definition of personnel authorized to reset the device, and the confirmation that there is no failure in the system and/or exposure of other workers to the associated hazards.

r) Criteria must be established and complied with to authorize the access to distribution panels and substation.

s) In high voltage panels, the temperature measurement in busbars and connections must be performed without opening the panel doors complying with the requirements of PNR-000131. In low voltage panels, the temperature measurement in busbars and connections must be performed in such a way that the workers do not exceed the working distance as defined in the incident energy study and in a specific procedure in accordance with item 10.7.3 of this document.

t) The use of metallic ladders in electrical work is prohibited.

u) The use of metallic scaffolding and other equipment made of conductive metal where they may come into contact with an energized surface is prohibited.

v) The planning of the activities carried out in the Electrical Shock Hazard Distance of energized overhead electrical lines must consider the implementation of all measures required to the control of the electrical risk.

10.7.2Procedures for de-energized electrical work

The local procedures to perform de-energized electrical work must be approved by a qualified professional and must contemplate as a minimum:

a) The scope of the job;

b) The identification of the equipment included in the scope of the job;

c) The identification and control/isolation measures for all parts and/or circuits which remain energized and exposed around the work area;

d) The job functions authorized to perform the job;

e) Training required to perform the job;

f) Requirements for electrical energy lockout as per requirements of RAC 04;

g) Requirements for voltage absence tests;

h) Tools/ equipment/ test meters compatible with the involved voltages;

i) Personal Protective Equipment compatible with the voltage levels and incident energy;

j) Steps, specific hazards and control measures to perform the job, also considering the Hazard Management Plan developed in compliance with PNR-000051 when applicable;

k) Additional control measures if the electrical work takes place in hazardous classified areas, wet/damp areas, underground areas, confined spaces or restricted areas.

10.7.3Procedures for energized electrical work

The local pr ocedures to perform energized electrical work must be approved by a qualified professional and must contemplate as a minimum:

a) The job scope;

b) Identification of the equipment contemplated in the scope of the job;

c) Area Manager Approval, based on a job risk analysis, testifying that the de-energization of the equipment or installation introduces additional or increased hazards or is unfeasible due to the equipment design or limitations of the equipment or type of job to be performed;

d) The identification and control measures of all parts and/or circuits which remain energized and exposed around the work area;

e) The job functions authorized to perform the job;

f) Training required to perform the job;

g) Number of people who will perform the job;

h) The requirements for continuous communication during the execution of energized electrical work;

i) Collective protective measures that must be installed (physical barriers, lockout of electrical energy, temporary grounding, etc.);

j) Personal Protective Equipment compatible with the voltage levels and incident energy;

k) Tools/ equipment/ test meters compatible with the involved voltages;

l) Steps, specific hazards and control measures to perform the job, also considering the Hazard Management Plan developed in compliance with PNR-000051 when applicable;

m) Additional control measures if the electrical work takes place in hazardous classified areas, wet/damp areas, underground areas, confined spaces or restricted areas.

10.7.4Electrical Switching Procedures

The local procedures to perform electrical switching must be approved by a qualified professional and must contemplate, as a minimum:

a) The description of the switching;

b) The identification of equipment which will be switched;

c) The Job Functions authorized to perform the switching;

d) Training required to perform the job;

e) Number of people who will perform the switching;

f) The requirements for communication during the execution of the switching;

g) The on-off switching and the insertion and extraction of circuit-breakers and contactors in electrical panels must, **preferentially**, be done remotely with the worker(s) not exceeding the safe approaching distances when the

panels are not resistant to internal arc and the switching cannot be performed with the working and adjacent doors or drawers closed;

h) Personal Protective Equipment compatible with the voltage levels and incident energy;

i) Steps, specific hazards and control measures to perform the job also considering the Hazard Management Plan developed in compliance with PNR-000051 when applicable.

10.8 Requirements for training

a) The workers who perform electrical work must be trained in Hazard Prevention in electrical works.

b) The workers who perform activities in Electrical Power Systems must have specific training according to local legislation.

c) The workers who perform electrical work in hazardous classified areas according to PNR000027 must have specific training.

10.9 Roles and responsibilities

10.9.1 Directors:

a) Assign one or more people responsible to:

I. Develop and maintain local procedures as described in sections 10.7.1, 10.7.2. 10.7.3 and 10.7.4 in this RAC;

II. Develop and maintain training programs and evaluation of workers who perform electrical work, as described in sections 10.7.1 and 10.8 of this RAC;

III. Develop a program to check the effectiveness of implementation of the requirements of this RAC;

IV. Guarantee the necessary resources to comply with the requirements of this RAC.

10.9.2Managers:

a) Assign the authorized professionals to approve the local general procedures, the procedures for de-energized works, the procedures for energized works and the procedures for electrical switching.

b) Formally approve the workers authorized to perform electrical work as per requirement 10.7.1.b of this RAC.

c) Approve the Risk Management Plan in case the calculated incident energy of the equipment where work will be performed is above 8 cal/cm^2.

d) Approve energized electrical work based on Risk Job Analysis testifying that the de-energization of equipment, installation or machine introduces additional or increased hazards or is unfeasible due to the equipment design or limitations of the equipment or type of job to be performed.

11 RAC-11 – MOLTEN METAL:

11.1 Foreword

Several serious and/or potentially serious events have occurred in the last 10 years, involving exposure of people to molten metal.

11.2 Purpose

Tostablish Health and Safety requirements to eliminate, control and minimize the risk of fatalities, injuries or incidents involving activities with molten metal.

11.3 Application

Activities involving molten metal, including but not limited to:

- Furnace;
- Converter ;
- Granulator;
- Transportation of molten metal (by heavy equipment and by crane);

11.4 Important definitions:

High Temperatures: temperature high enough to cause discomfort or even damage to the physical integrity of people and/or equipment.

11.5 Requirements for installations and equipment

11.5.1 General requirements:

a) Fire Protection and Suppression of the Furnace must be designed according to specific **PNR (PNR 000187- Protection and Fire Fighting System - Furnace and Boilers).**

b) Water based extinguishers shall not made be provided near the molten metal facility.

c) Design of the building must consider escape/ emergency routes in case of the emergency situation.

d) Building shall be designed with adequate floor drainage directing any water towards the side of the building, not allowing water accumulation.

e) Lounder must be designed to prevent the potential effects of a spill or splash of molten metal or must have temporary containment means.

f) Transfer lounder and molten material containment vessels must be designed in a way that provides a process for diversion of the material in the event of a possible spillage.

g) The gas analyzer (e.g. CO and SO2) must be installed around the building and audible and visual alarm must be activated when the presence of the gas is above the limit defined in local procedure.

h) Exhaust ventilation must be provided around the building to reduce dust particle and presence of toxic gas at the critical areas.

i) General Inspection program/ walkthrough must cover the presence of water on the building to avoid the risk of water contact with molten metal.

j) When applicable, leak detection system must be installed in the cooling water system. The monitoring system must be sensitive enough to indicate water leakage however small it is, avoiding its contact with molten metal.

k) A roof integrity program shall be executed to ensure roof integrity to prevent rain water going into the building.

l) Where applicable, temperature sensor/ transmitter shall be installed in the converter and furnace shell/ end wall refractory to enable early detection of hot spot (refractory failure).

m) Equipment used in molten metal activities must have an emergency stop, where applicable.

n) An emergency cooling water supply must be available in case of main cooling system failure. It must be also independent of power supply in case of power outage.

o) Intake and other feeding systems must be designed or automated in such a way as to keep people at a safe distance from charging points.

p) Furnaces and converters must have a monitoring and control system to reduce gases that can be generated during the process, such as CO, CO2, NOx, hydrogen or others.

q) The monitoring rooms must be endorsed with concrete protections resistant to impacts and to high temperatures.

r) It must be applied the online thermal monitoring for the convertor.

s) Where applicable, a level sensor/ indicator must be adopted to avoid overloading of molten metal into the convertor.

t) A monitoring level system must be applied to avoid overcharging of molten metal into the furnaces and to define the position of slag and matted inside the furnace.

11.5.2 PPE's and tools:

a) Personal and collective protection equipment (e.g. aluminized suite, gloves, hood, boots, etc.) must be purchased from registered manufacturers, in accordance with existing standards, approved and certified by the competent authorities. The protective equipment must be maintained and used in accordance with standard established by manufacturers.

b) Splashing shield must be installed to protect the worker from molten metal splash during the execution of tasks with risks of splashing.

c) The sampling tools must have adequate length to allow the sampling operator to perform the task from a safe distance.

d) When applicable, the personal gas detector (pocket detector) can be applied.

e) Workers who are working directly with molten metal or within the range of molten metal exposure must wear protective clothing (aluminized suite).

f) Employees working with molten metal must wear special protective goggles to visualize the baths of molten materials, avoiding visual fatigue or potential vision damage.

g) Tools applied for removal of slag, drilling, and leakage of molten metal must be free of rust and moisture before to use.

h) Other employees who are working or visiting molten metal area (but not working directly with molten metal) must wear fire retardant clothes.

11.5.3 Requirements for transportation and molten metal transfer equipment

a) Where applicable, hot metal transfer equipment must contain location/ positioning sensors connected to the tilting sensor of the equipment in order to ensure that the unloading of the molten metal is in the correct location.

b) Transfer routes of molten metal by road (haul master or other heavy equipment) must be well defined to minimize the risk of spillage during the road transport.

c) Overhead crane must be equipped with visual and audible alerts that indicating that molten metal transport and hot metal crane maneuver is taking place.

d) When applicable, hot metal cranes must have anti-collision sensors/ proximity alert to prevent collision among cranes.

e) Vehicle cabs, where practicable, which has potential exposure to splashing, explosion, or projection of molten metal must be protected with appropriate material (protective barriers).

f) Surfaces of equipment that come into contact with molten metal must be coated in such a way as to prevent exothermic reactions or leakage.

g) Transfer equipment must be designed to withstand exposure to high temperatures.

11.5.4 Gas treatment and cooling:

a) When applicable, gas washing and treatment systems must be provided with instrumentation to monitor:
   I. Composition of the generated gas (to monitor the percentage of H2, CO, CO2 and O2 and provide adequate alarms /interlocks).
   II. Gas flow and temperature.
   III. Gas washer water level alarm.
   IV. Interlocking for excessive fan vibration.
   V. Temperature of the filter sleeves.
   VI. Pressure monitoring.

11.5.5 Sinaling and warning:

a) Molten metal processing sites must have unique audible alarms that operate above ambient noise, which can be heard to warn the personnel in case of uncontrolled molten metal leakage or adverse reactions occur.

b) Warning plates must be durable in the environment in which they will be used, standardized and easy to view.

c) There must be a "Warning plate" with clear and permanent information informing the prohibition of the traffic of unauthorized persons in the areas handling matte, slag and other hot metal with proper size.

11.6 Requirements for procedures

11.6.1 General requirements:

a) Flammable and combustible products storage must be kept away from the working areas with molten metals.

b) Molten metal safety zones must be defined and documented as part of operational procedures.

c) Preventive maintenance programs must be established for all critical equipment used in molten metal process.

d) Preheating must be conducted if necessary to ensure no remaining water/ moisture inside the equipment that contain molten metal (e.g. ladles, pots, tundish).

e) When applicable, visual level monitoring by operator must be adopted to avoid overcharging of molten metals in equipment.

f) Communication and signaling systems must be applied consistently to reduce the risk of exposure to people working in the operations of molten metal.

g) The materials must be stored in a way that prevents contamination by moisture that may react with a molten metal bath.

h) Closed containers of insums are prohibited from being added directly to the molten metal due to the potential risk of explosion.

11.6.2 Emergency and rescue:

a) Emergency and Rescue Service must be in place to protect the workers handling molten metal, for which it must:

   I. Include in the emergency scenario involving molten metal.
   II. Training and drill of the brigade team for emergency care and response involving molten metal related incident.

b) The emergency preparedness and plan must be developed which include communication of an event, effective escape routes provision, and evacuation plan for people exposed to direct or indirect contact with hot materials, also for situations of spontaneous leakage, equipment stoppage, and isolation of the area in emergency situations.

c) When the furnace is loaded, there must be no employees positioned in the roof of the furnace.

d) Roof access control must be provided to avoid access to furnace roof when furnace is energized.

11.6.3 Requirements for transportation and liquid metal transfer equipment

a) Transfer equipment requires a traffic plan that includes routes and control over transfer speed.

b) Proper method such as road isolation shall also be provided when the road is also used by other vehicles.

c) Lifting movement of molten metal by the use of remote control can only occur:

   I. If the control site removes the individual from the imminent exposure for handling of molten metal and the associated risks.
   II. If the visual field of the area can be maintained at all times during the transfer process.

11.6.4 Requirements for inspection and monitoring:

a) Periodic inspection and, when applicable, pre-use inspection of molten metal transport and handling equipment, tools and accessories must be applied.

b) An inspection program must be established to routinely evaluate the mechanical integrity of the equipment (furnace, granulator, convertor, etc.) associated with the molten metal process to prevent equipment from further shell deformation.

c) Operational process control parameters must be continuously monitored.

d) inspection program must be established for gas exhaust systems associated with molten metal operations before they are put into service.

e) Processes must be established for routine monitoring of instrumented controls and visual inspection around the cooling water system to ensure that leaks do not go unnoticed.

f) Process monitoring alarm devices must be routinely monitored to identify operational parameters approaching or exceeding boundaries.

RAC 12 – HOT WORK

12.1 Preface

A significant proportion of critical incidents at Vale occurred during the execution of hot work. The main contributing factors to these incidents were:

a) Unsuitable/missing tools/equipment/devices

b) Failure to identify and assess risks

c) Knowledge/Skill

d) Failure in the planning/scheduling of preventive maintenance

e) Failure to define control measures

12.2 Purpose

Establish minimum requirements for hot work at Vale, to eliminate or control risk of fatalities and injuries.

12.3 Application

Applies to activities that may produce ignition sources, such as flames or sparks. Hot work includes electric and gas arc welding, aluminothermic or exothermic welding, gouging, grinding, burning and thinning, among others. In areas classified as flammable, all activities that generate rubbing or heat are classified as hot work.

12.4 Exceptions

a) Heat sources from machines and equipment (e.g. ovens, boilers, stoves, etc.) used in production processes;

b) Molten metal handling;

c) Use of grinder in the vulcanization process;

d) Storage of cylinders used for hot work when they are not being used for hot work tasks[32].

12.5 Definitions

- **Classified area:** areas in which an explosive atmosphere of gas is present or is expected to be present in quantities requiring special precautions.
- **Designated areas for hot work**: areas designed for hot work, with structures and control measures specific to this activity. They are usually more controlled environments, such as: boilermaking, machining, welding (pipeshop) and box sectors in maintenance workshops. The designated areas have higher safety for performing hot work, requiring fewer additional control measures.
- **Area not designated for hot work:** places that were not originally designed for hot work, and therefore do not have their inherent control measures for this activity. Generally, they are less controlled environments and have a higher potential for fire/explosion risk, such as: belt conveyors, electrical substations near combustible materials, green areas, gas stations, storage of flammable inputs/liquids, gas storage, tankage, among others.
- **Hot work authorization:** process by which the owner of an area not designated for hot work releases the clearence to perform hot work, using a specific form. This process is independent of the process of applying the SWP – Safe Work Permit.

[32] For storage, see PNR 00036 - Hazardous Materials Handling

- **Fire protection system**: any fire alarm device or system or fire extinguishing device or system, or a combination, that is designed and installed to detect, control, or extinguish a fire or to alert occupants, or the fire department, or both, that a fire has occurred. See PNR-000015 Fire Protection and Suppression Systems – General.
- **SWP:** Safe Work Permit.

12.6 Requirements for installations and equipment

12.6.1 General requirements for equipment and installation:

a) Fire extinguishers intended the hot work must be adopted.

b) Hot-working structures and buildings must be grounded.

c) Integrity of the grounding of the power circuit of welding machines must be ensured.

d) If hot work is carried out in tanks, closed containers, or places where liquids or gases may be present, the hot work area must be monitored with gas detectors for flammable vapors/gases before and continuously during the work.

a) If the lower explosive limit (LEL) readings exceed 1%, the activity must not be started and measures to clean the area of flammable vapor/gas accumulation and to identify the source for further corrective action must be taken.

b) Metal fume exhaustion must be implemented where there is no natural ventilation.

c) If gases are used, calibrated pressure regulators must be used, certified and in conformity with the gas used.

e) Eye protection against UV radiation must be used.

12.6.2 Requirements for transportation and packaging of hot work materials or equipment during the task:

a) The transport and packaging of the cylinder during the execution of the task must be done in a device designed for this purpose or have the validation of the Engineering area.

12.6.3 Requirements for isolation (applicable for all types of hot work):

a) Warning signs about the execution of hot work must be adopted.

b) A free area of at least 15 meters from the point of execution of the hot work must be adopted, free of the presence of people or combustible materials and equipment.

c) If it is not possible to adopt a free area of 15 meters, the area must be isolated with physical protection barriers, which must be non-combustible.

d) Combustible equipment or materials that cannot be removed from the isolated area must be protected with barriers, such as thermal blankets.

e) If the hot work site has a lower or upper floor opening, the determination of the hot work area must consider the risk of the ignition sources moving to the outside.

f) In remote areas, where It is not possible to implement a free area and the isolation , the following additional control measures must be adopted:

I. Make the firebreak of the place or wet the vegetation;
II. Adopt knapsack pumps;

III. Increase the number of people in surveillance and the monitoring time, according to local risk analysis or procedure.

12.6.4 Requirements for areas designated for hot work:

a) To be considered designed for hot work, the area must meet the following criteria:

I. Absence of combustible materials, products or equipment, excluding the materials and equipment that will be used in the hot work;
II. Have its own working structure for hot work, such as a bench;
III. Have a flame retardant cabinet for the storage of flammable materials;
IV. Have sprinkler protection, if walls and ceiling are made of combustible materials (as defined by the fire project in the area);
V. Have extra fire extinguishers for the activity, in addition to the fire extinguishers of use for local emergencies;
VI. Gas cylinders must be isolated from the risk of spark projection;
VII. Be periodically inspected to verify the presence of combustible materials, with the periodicity locally defined.

12.6.5 Specific Requirements for classified Areas

a) Emptying/inerting of the area must be applied to avoid accumulation of gases that may generate fire or explosion.

b) The area must have an artificial or natural ventilation system.

c) Line and equipment lockout must be applied, where the task is to be performed.

d) Access control must be adopted.

e) The area must have a preventive hydraulic system.

f) Flammable monitoring must be adopted, with an acceptable result equal to zero, to begin the task.

12.6.6 Requirements for Oxyfuel cutting:

a) The hot work cylinder must have a pressure and flow control system with two pressure gauges[33].

b) Backfire flame control devices must be used in the hose and torch feeds.

c) Specific hose must be used for the oxyfuel cutting equipment that complies with local legislation.

12.6.7 Requirements for use in electric welding:

a) VRD (Voltage Reducing Device) system must be adopted.

b) Residual current devices (RCD) in the sockets properly identified.

c) Deadman switch for MIG/MAG and TIG welds.

[33] Except for LGP gas

12.7 Requirements for procedures

12.7.1 General requirements for procedures:

a) Before the beginning of the hot work, the entire work area must be inspected[34] for the presence of combustible materials.

b) Pre use and periodic inspections must be applied tools and equipment used to do hot work.

c) An inventory of hot work of non-designated areas must be prepared, determining the type of construction and the presence of combustible or flammable materials.

d) Gas cylinders must be installed at a minimum distance of 3 m (three metres) from the heating equipment.

e) During use, the cylinders must be locked in the chain transportation device or in other device that prevents them from falling.

f) It is forbidden to wrap the hose around the body or parts of the body during the activity.

12.7.2 Requirements for oxyfuel cutting:

a) It is mandatory to depressurize the gas lines of the oxyfuel cutting equipment when not in use.

b) In non-designated areas, it is mandatory to remove the components of the oxyfuel cutting assembly when not in use.

12.7.3 Surveillance and Monitoring:

For classified areas and non designated areas, the following must be adopted:

a) Surveillance throughout the hot work, with a professional dedicated to watch and verify occurrences associated with fire or explosion.

b) Watching, after the hot work is concluded, for at least 1 hour, with criteria defined in a local procedure.

12.7.4 Authorization for hot work:

a) For classified areas and non designated hot work areas, the authorization for the execution of hot work must be obtained, containing, at least:

I. Information of where the work will be carried out

II. Fire Protection System Verification

III. Verification of the insulation and warns signs of the hot work area

IV. Verification of the presence of combustible or flammable materials

V. Atmosphere monitoring, when applicable

VI. Definition of surveillance and monitoring times

[34] This inspection can be incorporated into existing checklists or processes, such as ART, material and equipment checks, etc.

12.8 Requirements for training

Employees mapped in this RAC must receive the following training:

12.8.1 Firewatches:

a) Trainings in the Hot Work local procedure.

12.8.2 Performers:

a) Trainings in the Hot Work procedure.

b) Specific training for the activity (e.g. welding, oxyfuel cutting...) to be performed.

12.9 Roles and responsibilities

12.9.1Hot Work Performer:

a) Have exclusive dedication to monitoring the hot work activity that will be carried out;

12.9.2 Hot work watcher:

a) Contact the emergency area in cases of fire, in accordance with the local Emergency Response Plan.

b) Be exclusively dedicated to surveillance during the execution of the hot work.

12.9.3 Responsible for clearance of hot work (area owner):

a) Keep the areas under his/her management clean, organized and posted for risks of fire.

b) Prepare and maintain the updated inventory(s) of non-controlled areas under his/her management, for the execution of hot work.

13. RAC 13 – LINE AND EQUIPMENT OPENING:

13.1 Foreword

Line and equipment opening activities in the industry in general have caused serious events involving the exposure of people to dangerous fluids, materials with high pressures/flows and/or high or low temperatures, with disabling injuries and deaths.

The main factors associated with these events include:

- Failure to apply and to test the effectiveness of lockouts (zero energy) in accordance with RAC 04;
- Energy lockout applied to unsuitable valves/devices;
- Hazardous materials and/or residues not removed from lines and equipment downstream of the lockout;
- Pressure/flow not relieved;
- Hot or cold materials (e.g. water, nitrogen) not removed;
- Opening wrong lines and equipment;
- Lack of/failure in the isolation around openings;
- Lack of/failure to use appropriate PPE during the opening process;
- Lack of/failure in the grounding in lines and equipment in flammable service;
- Lack of/failure in environmental monitoring;
- Lack of/failure to monitor and/or to install inert gas pad in line and equipment openings in flammable service.

13.2 Purpose

To establish minimum requirements to preserve the lives of people at Vale, in activities that require the opening of lines and equipment connected to a process/system that contains hazardous fluids, materials at high or low temperatures, materials at high pressure or flow and where there is the potential for exposure of people.

Applies to activities that may produce ignition sources, such as flames or sparks. Hot work includes electric and gas arc welding, aluminothermic or exothermic welding, gouging, grinding, burning and thinning, among others. In areas classified as flammable, all activities that generate rubbing or heat are classified as hot work.

13.3 Application

Maintenance or service activities involving the opening of lines and equipment, in order to ensure control of the potential for a release of hazardous fluids.

13.4 Exceptions

This RAC does not apply to:

- Routine sample collection activities and product loading and unloading operations, carried out by trained and authorized professionals and covered by specific operating procedures;
- Opening containers not connected to a process/system (e.g. drums, totes, isotanks, cylinders);
- Opening water lines at temperatures below 60ºC and pressure below 10barg;
- The use of water, air, steam or condensate, nitrogen or other inert gases from utility stations and hoses, valves and fittings that have been designed for this purpose, allowing contact with the atmosphere, provided they are covered by specific operating procedures;
- Opening hydrants during tests and emergency response or using and testing safety showers and/or eye washers;
- Opening LPG lines when in use in restaurants (e.g. stoves);
- Opening liquid nitrogen, LPG and fuel lines when the activity is carried out by the product supplier (e.g. unloading a truck into a specific storage tank);
- Opening laboratory and bench lines and equipment, provided they are covered by specific operating procedures;

- Pigging of pipelines carried out by trained and authorized professionals and covered by specific operating procedures

13.5 Definitions

- **Line and equipment opening:** intentional opening of a pipeline, pipe (including tubing), equipment or connection, cleared or not, which contains or has contained hazardous fluids and/or materials at high or low temperatures and/or at high pressures/flows, capable of causing personal injury. This may include, but is not limited to:
  I. Opening connections (quick couplings, flanges, threaded connections, etc.);
  II. Opening pipes or pipelines by hot or cold cutting;
  III. Removal of one or more flange bolts;
  IV. Opening valves and vessels under pressure to the atmosphere;
  V. Removal of block and check valves and their components;
  VI. Installation of blind flanges, paddle blinds and spectacle blinds;
  VII. Opening pressurized hydraulic fluid hoses on fixed and mobile equipment;
  VIII. Replacement of seal gaskets in pipes;
  IX. Removal of blind flanges, plugs, stoppers and caps;
  X. Disconnection of pipes and pressure vessels, e.g. compressed air;
  XI. Installation of fittings in pipes by mechanical or other means;
  XII. Opening of doors, windows or manholes;
  XIII. Adjustments of valve or pump gaskets.
- **High pressure:** above 10 barg (150 psig).
- **Equipment:** Assets such as tanks, pumps, furnaces, compressors, pressure vessels, boilers, among others**.**
- **Hazardous fluids:** see definition in PNR000198.
- **PIG PASSAGE:** requirements in PNR-000049.
- **PIG:** see definition in PNR000198.
- **High temperature:** above 60ºC.
- **Low temperature:** below 0ºC.
- **Pipes or Lines:** see definition of piping systems in PNR-000198.

13.6 Requirements for installations and equipment

12.6.1 Isolation devices such as paddles, spectacle blinds, blind flanges, and sealing elements such as gaskets must be suitable for the pressure class of the line and equipment and compatible with the material contained in the line and equipment.

12.6.2 In areas classified according to PNR-000027, lighting devices, measuring instruments, equipment and tools must be classified for use in flammable atmospheres.

12.6.3 Equipment and lines must have grounding systems in accordance with PNR-000052.

13.7 Requirements for procedures

13.7.1 Planning

a) Activities must be planned in such a way as to ensure faithful compliance with the requirements in this document.

b) The need for assessment and monitoring of the atmosphere/air quality (initial and periodic) must be defined, in order to guarantee airborne concentrations of dangerous substances, explosive limits and/or oxygen limits within acceptable limits, according to the fluid in the line and equipment.

13.7.2 Lockout

a) The requirements set out in RAC 04 – Lockout, Tagout and Zero Energy, must be met in order to lockout the line and equipment.
b) The following hierarchy must be followed for lockout of lines and equipment:
   I. Physical disconnection;
   II. Block valve and paddle, blind flange, spectacle blind;
   III. Double block, drain and vent: two in-line valves closed with an open drain and an open vent between the closed valves or with an open drain or an open purge between the two closed valves;
   IV. Two in-line valves closed. It is forbidden to apply this type of lockout to liquefied gases under pressure at room temperature.
c) It is forbidden to use check valves, control valves, circuit control switches and automatic fail-safe valves in the open position to make lockouts.
d) Additional measures must be taken to ensure the integrity of automatic fail-safe valves in the closed position by disconnecting the automatic drive source.

13.7.3 Preparation

a) Preparation for opening must include depressurizing, draining, venting, purging, and flushing the line and equipment.
b) The contents of the line and equipment must be drained to a safe place to avoid exposing people and the environment, as well as to prevent fire risks.
c) In the case of flammable products, the integrity of the line and equipment grounding must be checked.
d) In the case of flammable products, the line and equipment to be opened must be inerted when indicated in the Safety Data Sheet (SDS) and/or in the Task Analysis.
e) Atmosphere/air quality assessments (initial and periodic) must be carried out to ensure that concentrations of hazardous substances and explosive or oxygen limits are within acceptable limits before opening begins, as defined in the planning stage.

13.7.4 Isolation of the opening area

a) The area around the opening point(s) of the line and equipment must be isolated with rigid barriers, at a distance compatible with the engineering standards established for each product and pressure in the line.

13.7.5 Identification of the opening point(s)

a) Opening points must be physically identified or a trained and authorized person must be present at the moment of the line and equipment opening.

13.7.6 Opening

a) Local procedures for carrying out activities involving the opening of lines and equipment must include, as a minimum:
   I. the scope of the work;
   II. identification of the line(s) and equipment included in the scope
   III. The functions authorized to perform the opening;
   IV. The training required to perform the opening;
   V. The method(s) used to confirm that the line and equipment has been properly cleared, that contents have been reduced to acceptable levels and that isolating devices are effectively closed and locked in accordance with RAC-04;
   VI. The tools, equipment and measuring instruments to be used;
   VII. Personal Protective Equipment (PPE) defined according to the hazards identified in each phase of the opening;
   VIII. The methods used to open the line and the equipment;

IX. Indication of the type(s) of monitoring and location of the measuring instruments, if monitoring is required as defined in the planning stage.

b) For activities of line and equipment opening involving confined space entry and/or hot work, compliance with the requirements set out in RAC 06 – Confined Spaces and RAC 13 – Hot Work must be ensured.

13.8 Requirements for training

a) Workers who perform activities involving line and equipment opening must be trained in the Prevention of Risks in Line and Equipment opening.
b) Workers who perform activities of lines and equipment opening in classified areas must have specific training in accordance with PNR-000027.

13.9 Roles and responsibilities

13.9.1 Directors:

a) Assign one or more people responsible to:
   I. Develop and maintain local line and equipment procedures as per requirements 12.7.6 a and b in this RAC;
   II. Develop and maintain training programs and evaluation of workers who perform line and equipment opening as per requirements 12.8 a and b in this RAC;
   III. Develop a program to check the effectiveness of implementation of the requirements of this RAC;
   IV. Guarantee the necessary resources to comply with the requirements of this RAC.

13.9.2Managers:

a) Assign qualified professionals to approve local line and equipment opening procedures.

b) Formally approve the workers authorized to perform line and equipment opening.

ANNEX I - Requirements for safe scaffolds:

The use of individual fall protection system can be exempted for the workers that perform activitites on safe scaffolds used as a workplace, provided that the following requirements are met:

I. Absence of additional external risks or interferences that, directly or indirectly may affect the safety of the worker.
II. The worker does not need to project his body over the guardrail during the activity.
III. The scaffolds are assembled where there is no risk of falls due to a surface collapse.
IV. The scaffold is designed, dimensioned and assembled under the responsibility of a certified professional, according to the technical standards or local legislation.
V. Metallic scaffolds, of tubular, platform or multidirectional types, outfitted with protection on the clamps at access and workplace locations.
VI. Scaffolds with shoes supported on a solid base, mounted on a flat, horizontal, resistant surface, free from damage or deformation.
VII. Scaffolds formally released for use, after:
   a) Verification of conformity with the project
   b) Issuance of a formal release document, with no non-conformances, filled in by the scaffold inspector and the SWP Issuer
   c) Visible plate showing the maximum workload allowed
   d) Indication of release in the plate of release

VIII. Whenever the workplace offers a complete protection against fall risks, that is, the scaffolds that have:
   a) Guardrail with minimum height of 1.20 meters for the upper rail, 0.7 meters for the intermediate rail and 20 cm toeboard around the perimeter
   b) Access ladder as part of the structure
   c) Gate or other means of protection around gaps generated by the access means to the workplace.
   d) In case of access through trapdoors, physical rigid barriers around them, so as to avoid falling of people.

The exemption for the use of personal fall protection system does not apply to suspended, cantilever, mobile supported (wheels) scaffolds, nor to rack platforms.

Other situations involving activities carried out on scaffolds which may generate a risk of falling from a level superior to 1.8 meters must adopt control measures defined in the hazard analysis, specially related to the access to the workplace on the scaffold.

ANNEX II - Internal Traffic Plan

The traffic plan must include at least the following basic elements:

a) Purpose:
   I. Purpose of the internal traffic plan.

b) Responsibilities:
   I. Describe the responsibilities under the internal traffic plan.

c) Traffic Rules - Describe local rules from/to:
   I. Traffic (general) and circulation, including overtaking;
   II. Speed limits, considering adverse weather conditions;
   III. Safety distances and restricted areas (exclusion zones);
   IV. Parking lots (position, distance, etc.);
   V. Approaching mobile equipment or mobile equipment areas;
   VI. Access of Truck/cargo, use of spotters/observers Traffic of special cargo (chemicals, explosives, liquid metals);
   VII. Emergency situations (e.g. collision, rollover, fire, explosion, projection of materials, crushing and running over) and towing;
   VIII. Abnormal situations in motor vehicles and mobile equipment;
   IX. Interaction between vehicles and equipment, including guidelines on the use of communication devices;
   X. Communication between pedestrians, vehicles and equipment;
   XI. Road block;
   XII. Priority to the right between vehicle/equipment and pedestrian types;
   XIII. Instructions on drilling, disassembly and disassembly siege areas, where applicable.

d) Parking Areas:
   I. Describe the parking areas by vehicle type and parking position;

e) Roads - Describe the process for defining and reviewing roadways (design, layout, directions, slopes, surface, traffic control). The roads must be defined to:
   I. Maximize the segregation of vehicles/equipment from other objects, including pedestrians, buildings, sidewalks, safe paths and other vehicles/equipment;
   II. Consider paths and/or routes in case of emergencies;
   III. For the transport of liquid metals, consider the possibility of exclusive internal roads and request the approval of traffic agencies for circulation on public roads.

f) Pedestrian Safety and Internal Road Control Measures:
   I. Describe the process for defining and maintaining pedestrian safety and internal road control measures (vehicle types, traffic, distances, guardrails, insulation barriers, sidewalks, among others);

g) Lighting:
   I. Describe the process for defining and maintaining the traffic lighting and operation roads;

h) Signs:
   I. Describe the process for defining and maintaining traffic signs (speed limits, directions, permissions and prohibitions, parking areas, crosswalks, intersections or roundabouts, level crossing, among others).

ANNEX III – Minimum Criteria for a Rigging Plan

The Rigging Plan must include the following technical information:

a) General:
   I. Company Name, place of work, work area, workpiece to be lifted / moved, workpiece weight;
   II. Calculation memory, device designs, demonstrative drawings of all lifting phases, the most critical positions and expected clearances in relation to interference.
   III. Stages where supervision by the Rigging supervisor will be mandatory, being mandatory at least during the lifting of the load.

b) Operational detailing:
   I. Crane Identification: make, model, rated capacity and Series, outriggers area;
   II. Crane configuration: boom, crane capacity, workpiece net weight, attachment weight and block, operating radius, gross load weight, cable runs (number of cable legs), counterweights, shoe positioning, JIB length, JIB angle and etc;
   III. Crane Utilization Percentage: Classification as a percentage of crane utilization in the operation in question;
   IV. Crane gross capacity: according to load table values and crane lifting diagram, safety factor, load factor.

c) Lifting:
   I. Determine lifting accessories, wire rope loops (units), cable capacity, shackles, shackle capacity, type of lashing, other materials, capacity of other materials, lashing design.

d) Rolling and positioning:
   I. Shoe force / maximum load on the paddle, padding material (metal or wood), padding area, required minimum ground strength, padding detail and positioning (drawings);

e) Additional safety information related to load lifting:
   I. Maximum allowable wind speed for crane.

f) Site / area visit data (where applicable):
   I. Date of the technical visit, name of the person responsible for the technical visit, name of the person providing the information, date of preparation, name of the developer, date of revision, name of the controller.

g) Drawings:
   I. Complete layout of the operation with top, side, perspective, interference (electrical networks, equipment, installations, roads, access, gutters, culverts, ditches, pipelines, etc.) and their respective dimensions with technical drawing made by hand or through specific software.

h) Approvals:
   I. Signature of own or contracted rigger, area / customer signature, reviewer rigger signature, where applicable and date.