Group Standard

D1 – Underground safety

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<th>Group standard</th>
<th>Title: Underground safety</th>
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| Function: Health, Safety, Environment and Communities (HSEC) |

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| Owner: Global head of Health, Safety, Environment and Communities |
| Approver: Executive Committee |

| Target Audience: All Rio Tinto staff and each Rio Tinto Group business and function |

| Direct Linkages to other relevant Policies, Standards, Procedures or Guidance notes: |

- Rio Tinto management system standard; Safety standard D1 – Underground standard guidance notes |

| Document purpose: |

This standard relates to the management of risks associated with underground mining activities |
D1 – Underground safety

Intent and scope
This standard applies to all Rio Tinto managed operations and projects including;

a) Underground mines
b) Existing sites and new acquisitions where **underground excavations** exist
c) Exploration, through all development phases and construction
d) Operation through to closure
e) Post-closure management (where applicable)

Where an **underground excavation** is not intended or designed primarily as a place of work, this standard must be read in conjunction with the Rio Tinto safety performance standard C5 – Confined Spaces.

The level of effort required to demonstrate compliance with this standard is guided by the D1 Guidance Notes.

Where a word or term in this standard is in bold type, the definition for that term can be found in the HSEC definitions database on the Group HSEC portal.

All requirements outlined in this standard are management requirements, and are therefore assured through the HSEC Business Conformance Audit process

Control requirements
Specific management requirements in the remainder of this performance standard apply in addition to any general requirements defined in the Rio Tinto Management System.
D1.1 Ground control

Planning

1.1.1. Each Operation that has underground excavations where people work must nominate a manager who is responsible for the implementation of this standard who shall:
   a) Ensure that a ground control risk assessment is carried out to evaluate possible failure mechanisms leading to falls of ground, rock burst or collapse
   b) Arrange for the development of a Ground control management plan that consists of three elements: planning, implementation and operation, and monitoring
   c) Approve the Ground control management plan.

1.1.2. The Ground control management plan shall:
   a) Be designed by a competent person or group
   b) Specify the design rationale, calculation methods, and support systems
   c) Ensure that all underground excavations, drives, stopes and shafts are designed to specified and documented minimum stability criteria for all relevant geotechnical domains. The design must ensure that all personnel work in a secure environment
   d) Require that the support designs take into account the purpose and duration of the planned excavation life cycle
   e) Ensure that the design takes into account any factors relevant to the geotechnical, geological and hydrogeological setting, mining method and sequence
   f) Specify the material properties used for all support elements;
   g) Document pillar design criteria and, where pillars are required for reasons of safety, ensure they are clearly marked on all mine plans and sections
   h) Address specific ground control hazards and personnel exposure identified in the risk assessment
   i) Specify the requirements for provision of secondary means of egress (refer to Safety Standard D1.2.8).

Implementation and operation

1.1.3. Protocols must be developed to ensure that no personnel work beneath ground that has been inadequately secured.

1.1.4. Protocols must be developed and documented for all aspects of ground control activity. These protocols must specify:
   a) The persons authorised to install support in accordance with approved design and the training they require
   b) The persons authorised to install additional, unplanned support and the training they require
   c) The tools and equipment required to install ground support, to monitor and inspect, which cater for all sizes of excavation encountered in the mine
   d) The tools and equipment required for scaling to cater for all sizes of excavation encountered in the mine and, which will allow the removal of loose material without exposing the person performing the work to injury
   e) The persons authorised to scale and the training they require
   f) Planned job observations of scaling and support practices at a frequency defined by supervisors and senior management
   g) Development methodology, including perimeter control
h) Breakthrough of development headings
i) The documentation of as-built drawings of developed excavations and the installed support.

1.1.5. All underground employees and contractors must be trained in awareness and communication of ground control hazards. Underground supervisors and personnel engaged in specialist ground support activities will undergo specific training in ground control hazard identification and mitigation.

1.1.6. Protocols must be defined for information flow between shifts and between technical and operations management.

1.1.7. Any change to the Ground control management plan must follow a management of change process as indicated in Rio Tinto Management System - Element 11.

Monitoring

1.1.8. Procedures must be in place that define:

a) The frequency and responsibility for inspecting, monitoring, evaluating and reporting on ground conditions in:
   - Active workings
   - Shafts, declines, access ramps, airways, escape ways, etc
   - Other key sections of the mine.

b) The quality assurance and quality control (QAQC) requirements for:
   - Support elements
   - Development of excavations, i.e. overbreak, survey accuracy, etc
   - Mining sequence, including geometry, rate, etc

c) The responses appropriate when monitoring or QAQC programmes identifies deviations or failures. A Trigger action response plan (TARP) must be developed for each monitoring or QAQC programme.

1.1.9. In addition to the inspections specified in 1.1.8 a) all underground excavations must be reviewed on a periodic basis to:

a) Evaluate conformance to the Ground control management plan and local regulatory requirements

b) Re-evaluate possible failure modes, monitored rock mass response and up-date risk management studies

c) Ensure any changes in purpose or planned life of excavations are identified and incorporated into revised design parameters

d) Arrange for peer review of standard work procedures.

1.1.10. The Ground control management plan shall be reviewed by a competent, independent person or group every two years or more frequently as determined by risk assessment.
D1.2 Emergency procedures

Planning

1.2.1 Each operation that has underground excavations where people work must nominate a manager who is responsible for the implementation of this standard who shall:

   a) Ensure a risk assessment is undertaken to identify and evaluate the potential emergency situations that might occur within the underground operations;

   b) Arrange the development of an Emergency Response Plan that consists of three elements: planning, implementation and operation, and monitoring; and

   c) Gain approval of the Emergency Response Plan by the Site Senior Operational Leader.

1.2.2 The Emergency Response Plan shall:

   a) Be developed by a competent person or group;

   b) Identify the potential of emergency situations and their duration;

   c) Provide written procedures developed in response to the identified potential emergency situations;

   d) Be reviewed and updated annually or more frequently as operational activities necessitate; and

   e) Incorporate the elements in Sections 1.2.3 through 1.2.12.

Implementation and operation

1.2.3 All persons who work in the underground operations must be trained annually in accordance with a formal documented competency based training plan, or more frequently as operational activities necessitate, in what to do in the event of an emergency situation.

Visitors must receive instruction in the use of safety equipment, specifically SCSRs and / or CABA units, and emergency procedures and must remain with the operations representative at all times while underground.

Procedures must be in place to ensure all persons who work in the underground operation are advised when a change in the escape and evacuation plans takes place.

1.2.4 Each operation must establish and maintain evacuation routes including secondary egress as close as practicable to existing and planned working areas. Safe Working Practice (SWP) for single entry systems must be established. The SWP must state the authorised activities, the maximum distance allowed before an alternate secondary means of egress or a refuge chamber is required, the maximum number of personnel allowed, and any particular PPE or other precautions that are necessary.

1.2.5 An effective method must be used to demarcate all evacuation routes.

1.2.6 Each operation must establish the need, location and capacity for Self Contained Refuge Chambers and Fresh Air Bases.

Location of Self-contained Refuge Chambers and Fresh Air Bases must consider the capacity of self contained self rescuers (SCSRs) used in the underground operations, the potential for flooding, inrush and inundation, thermal extremes and evacuation routes. Clear and highly visible signs must be used to demarcate all evacuation routes.
1.2.7 Each underground operation must have an effective system, together with at least one back up system, to warn all personnel in the underground operation, that an emergency situation exists. The minimum acceptable time for an emergency warning to reach all personnel in the underground operation must be determined.

1.2.8 A maximum period of time from the moment the emergency warning is activated to the time the last personnel evacuate the underground operation or are able to reach the safety of an underground Self-contained Refuge Chamber or Fresh Air Base must be set. In setting this time period, the capacity of SCSRs and CABA, and the potential impacts of the emergency must be considered.

1.2.9 Each operation must have an effective system and procedures to identify who is in the underground operation.

1.2.10 The Emergency response plan must incorporate the involvement of the in-house mine rescue teams, third party mine rescue teams (where available) and the use of local emergency services, as appropriate, in order to provide adequate capacity for the duration of the identified potential emergency situations.

1.2.11 Any changes to the services within the underground operations, for example, ventilation settings, power supply, water and pumping arrangements, etc, during an emergency situation shall require the authority of the Incident Commander.

Monitoring

1.2.12 All personnel who work in the underground operation must, as far as reasonably practical, participate in an evacuation on an annual basis.

These evacuations should include the use of Self-Contained Refuge Chambers and Fresh Air Bases.

These evacuations should include critical elements of the Emergency Response Plan and learnings from these evacuations shall be included in the review of the Emergency Response Plan.
D1.3 Fire precautions

Planning

1.3.1 Each operation that has underground excavations where people work must nominate a manager who is responsible for the implementation of this standard who shall:

a) Ensure that a Fire Risk Assessment is carried out to evaluate the types of possible underground fire events;

b) Identify the location and quantities of fuel sources;

c) Identify the location and types of ignition sources;

d) Analyse the consequence and likelihood of each fire event;

e) Identify controls used to minimise the identified fire risk;

f) Develop the underground operation’s Fire Control Plan; and

g) Gain approval of the Fire Control Plan by the Site Senior Operational Leader

1.3.2 The Fire Control Plan shall:

a) Be designed by a competent person or group;

b) Establish a Fire Risk Register that is reviewed annually;

c) Apply fire prevention and mitigation control to the design, placement, and operation of infrastructure / plant, fuel, combustibles and explosive materials storage areas;

d) Establish a system for the installation, inspection, and maintenance of fire detection, warning, and suppression systems;

e) Provide for real-time carbon monoxide monitoring in major ventilation circuits of the mine including the associated TARPs;

f) Establish fire response capabilities available at all times when people are underground. This will include First Responders capability achieved through annual training for all underground personnel to recognise and respond where appropriate, through to specific Mines Rescue capability;

g) Designate all underground areas as “No Smoking”, including the use of electronic cigarettes;

h) Identify prohibited items and establish a system to prevent these items entering underground areas;

i) Include the requirement for self-contained self-rescuers (SCSR) with a minimum capacity of 30-minute oxygen supply;

j) Provide for caches of additional SCSR, determined by a risk assessment; and

k) Be reviewed annually by a competent person or group.

1.3.3 A competent person or group must design the following systems:

a) Fixed and portable fire detection;

b) Warning;

c) Suppression;

d) Alarms; and

e) Equipment.
Implementation and operation

1.3.4 Where likelihood for spontaneous combustion of in situ materials exists, a Spontaneous combustion management plan must be implemented.

1.3.5 Where the risk of fire from hot work exists, hot work procedures and permit systems must be implemented.

1.3.6 Petrol (gasoline) powered equipment must not be permitted underground.

1.3.7 Where mobile equipment is used underground, the following controls must be implemented:
   a) Mobile equipment is fitted with a hand held extinguisher mounted on the unit in an accessible location, the size and type of which is determined by a risk assessment;
   b) Mobile equipment containing more than 100 litres (26 gallons) of flammable hydraulic fluid is fitted with an automatic fire suppression system with suitable manual activation;
   c) Fire suppression systems must be able to be activated from inside and outside of the operator’s cabin;
   d) Pre-shift inspections are carried out for mobile equipment to check for leaks and associated accumulations of hydrocarbons, and to confirm the operating status of the emergency shutdown, isolation and fire suppression system; and
   e) Engine components including electrical and hot surfaces, that are a potential ignition source are shielded from exposure to fuel sources, where practicable.

1.3.8 Flammable storage, fuel dispensing, workshops, substations and explosive storage should be placed in exhaust airway locations or automatically ventilated direct to exhaust. Where this is impracticable, the installation of fireproof ventilation doors should be considered to minimise the potential for smoke and toxic fumes entering the working area.

1.3.9 Where there is a risk of fire from flammable and combustible materials, the following controls must be implemented:
   a) Storage of flammable and combustible materials is minimised;
   b) Flammable and combustible materials are isolated from ignition sources;
   c) Fire resistant hydraulic fluids are used, where practicable;
   d) Pipelines delivering hydrocarbons are periodically inspected and identified leaks are repaired;
   e) Pipelines delivering hydrocarbons are run empty at the end of filling cycles; and
   f) Storage of flammable liquids, combustible materials or explosives shall not be within 50 metres of the shaft, adit or ventilation intakes.

1.3.10 All new electrical installations must use fire retardant, low-toxicity cables, where practicable.

1.3.11 Heating, ventilation and air-conditioning (HVAC) and intake air heater systems must:
   a) Have emergency shutdown capabilities;
   b) Be provided with a fire suppression system; and
   c) Real-time carbon monoxide monitoring.
D1.4 Hoisting and shaft sinking

Planning

1.4.1 Each operation must identify and assess potential hoisting and shaft sinking risks.

1.4.2 Where there is a hoisting system, the operation must nominate a manager who will develop a Hoisting plan. The Hoisting plan must:
   a) Be designed by a competent person or group
   b) Establish hoist control methods
   c) Establish maximum hoist speeds and deceleration rates
   d) Provide for soft stopping and emergency stopping
   e) Provide for overwind and underwind prevention
   f) Specify maximum allowable load
   g) Establish the frequency and method for testing of all safety devices and control systems
   h) Establish a plan for the inspection, maintenance, and modification of the hoisting system
   i) Be reviewed by an independent competent person or group every two years, or more frequently as determined by a risk assessment or event

1.4.3 Where shaft sinking is conducted, the operation must nominate a manager to develop a Shaft sinking management plan. The Shaft sinking management plan must:
   a) Be designed by a competent person or group
   b) Provide specifications for the shaft, winches, work-stage and other shaft sinking equipment
   c) Establish controls specific to shaft sinking hazards
   d) Be reviewed by an independent competent person or group before construction is commenced
   e) Establish a system of periodic structural inspection of the work-stage
   f) Be reviewed by an independent competent person or group every two years or more frequently as determined by a risk assessment or event

1.4.4 A competent person must design shaft infrastructure. An independent competent person or group must then review this design prior to construction or installation.

1.4.5 Any modifications to shaft infrastructure, work-stages, or hoisting equipment must be subject to engineering review by a competent person or group.

Implementation and operation

1.4.6 Hoisting systems must be provided with the following safety devices:
   a) Hoists used for transporting personnel shall have at least two sets of mechanical brakes to stop and hold the drum, one of which must apply directly to the drum
   b) Primary and secondary protection against over travel and over speed
   c) An interlock system, for all hoists fitted with a clutch, to ensure the free drum is braked and the driven drum is limited to creep speed
   d) A device to stop the hoist in the event that the conveyance does not move in relation to the amount of rope paid out.
   e) Indicators to show the location and speed of conveyances in the shaft
   f) An emergency off switch
   g) Ammeter to indicate the winder motor current
1.4.7 All conveyances used for transporting personnel must have a:
   a) Secondary emergency egress should the primary conveyance become inoperable
   b) System to prevent the conveyance from falling in the event of a rope failure except in
      shaft sinking, major shaft rehabilitation or refurnishing applications

1.4.8 Any rope used as part of the hoisting system must have established:
   a) Rope manufacturing quality assurance and quality control criteria for all rope
      procurements
   b) Rope inspection and maintenance criteria for all ropes either in storage or in service
   c) The method and frequency of rope end cuts and rope end cut testing
   d) Discard criteria that addresses strength loss, corrosion, deformation and physical
      impairment

1.4.9 Operations must maintain records of hoist rope data including, date of installation, serial
   number, maximum admissible legal life, end cut test results, manufacturing date, and safety
   factors.

1.4.10 Conveyances and rope connecting attachments must be:
   a) Designed or selected by a competent person
   b) Provided with up to date engineering drawings
   c) Provided with manufacturing quality assurance and control established for
      procurement
   d) Maintained on a register that includes their serial number and rated load

1.4.11 Conveyances used for transporting people must have two independent means of
   communication with the hoist operator.

1.4.12 Persons who operate, inspect, maintain, or test any part of the hoisting system
   must be trained, competent and authorised to do so.

1.4.13 Operations must implement a Maintenance and inspection plan for:
   a) Mechanical and electrical components of the hoists and shaft infrastructure
   b) Hoist rope attachments and conveyances
   c) Structural integrity of hoists and shaft infrastructure
   d) Safety devices and control systems
   e) Non-destructive testing (NDT) of critical hoist components, ropes, attachments, conveyances and infrastructure

1.4.14 Communication protocols between management and those carrying out maintenance and
   inspections must be established to ensure the timely notification of adverse findings

1.4.15 Shaft sinking safety devices must include:
   a) Stage rope load indicators that are visible to the hoist operator
   b) Engineered fall protection devices for conveyances and work-stage
   c) Bucket movement controls above and below work stage
   d) Fully enclosed bucket wells with signalling devices

1.4.16 Persons must be tied off while travelling in a conveyance, unless the conveyance is fully
   enclosed.
D1.5 Explosive and hazardous atmospheres

Planning

1.5.1 Each operation must identify the potential for a **hazardous atmosphere** that may be harmful to personnel in the underground environment.

1.5.2 The **risk assessment** for a **hazardous atmosphere** must consider the potential for harmful effects from:

   a) Naturally occurring gases within the strata and ore body
   b) Gases liberated or created due to operational activities
   c) Pre-existing gas reservoirs in the vicinity of operations
   d) Spontaneous combustion of ore or waste
   e) Combustible dust forming an **explosive** mixture

1.5.3 Where there is a risk of **hazardous atmospheres**, the operation will nominate a manager who must develop a Ventilation management plan. The Ventilation management plan must:

   a) Be designed by a **competent person** or group
   b) Specify a **ventilation system** that provides a sufficient volume, velocity, and quality of air to prevent **hazardous atmospheres**
   c) Provide for real-time carbon monoxide monitoring in major ventilation circuits of the mine
   d) Establish a programme of inspection and maintenance of the **ventilation system**
   e) Establish a programme of periodic monitoring and testing of the **ventilation system** carried out by a competent person or group
   f) Incorporate a **Trigger action response plan** (TARP) prescribing the preplanned response to escalating levels of risk for **explosive** gases, thermal stresses, toxic and asphyxiating gases
   g) Establish a system of monitoring for potentially harmful or **explosive** gases and dust that is designed by a **competent person** or group

Implementation and operation

1.5.4 Where the potential for hazardous levels of combustible dust exist, the following controls must be implemented:

   a) Limiting the amount of dust generated.
   b) Suppression, collection and removal of dust at points of generation
   c) Regular inspection for and removal of dust accumulation from infrastructure
   d) **Inertisation** to treat coal dust

1.5.5 Where the potential for a combustible dust explosion exists, there must be the means to minimise propagation of an explosion.

1.5.6 Where there is a risk of accumulation of harmful levels of gases, the following controls must be implemented:

   a) Predetermined limits with appropriate factors of safety
   b) Provision of sufficient volume, velocity, and quality of air to reduce the gas to an acceptable level
   c) Assessment and monitoring of gases prior to entry and while working in the location
   d) **Trigger action response plan** (TARP) prescribing the pre-planned response to escalating levels of risk
e) Controls to prevent unauthorised access to areas containing a **hazardous atmosphere**

1.5.7 Where there is a risk of a gas ignition or explosion, the following controls must be implemented:
   a) Elimination or control of ignition sources
   b) Use of intrinsically safe equipment

1.5.8 Where continuous monitoring is used, the system must alarm at predetermined concentrations and activate a notification system.

1.5.9 Where potential for **explosive** or **hazardous atmospheres** exist:
   a) Underground personnel must be trained in the recognition of signs, indicators, and hazards of mine gases
   b) Preventive measures and emergency procedures must be provided for
D1.6 Inflow or inundation of liquids

Planning

1.6.1 Each operation must identify and characterise the geological, hydrogeological and geotechnical feature(s) to determine the potential for uncontrolled inflow and inundation.

1.6.2 Where the hazard of uncontrolled inflow and inundation exists, the operation will nominate a manager who must establish and implement an Inflow and inundation management plan. The Inflow and inundation management plan must:

- Be based on a risk assessment of potential uncontrolled inflow and inundation carried out by a competent person or group
- Implement controls for identified risks
- Incorporate a Mine water management system
- Be reviewed by an independent competent person or group every two years or more frequently as determined by a risk assessment, event or when there is a material change to the mine plan

1.6.3 The risk assessment for inflow and inundation must consider the following sources as a minimum:

- From a major water bearing structure/feature
- Along each high risk structure/feature as determined by a competent person
- From drill holes, flooded historical workings, and/or adjacent mines
- Due to failure of a water retaining pillar
- Due to failure of a water retaining structure
- Due to surface waters entering the mine
- From improper design or operation of a Mine water management system

Implementation and operation

1.6.4 The design and location of mine entry points must consider the potential for inflow and inundation.

1.6.5 Inflow and inundation hazards specific to the work areas must be included on up-to-date mine plans. Potential inaccuracies in the location of the historical workings and/or workings from adjacent mines must be indicated on up-to-date mine plans.

1.6.6 Procedures must be established for managing an intersection with a drill hole or breakthrough to a historical working or adjacent mines.

1.6.7 The operation must retain relevant available information including:

- Historical mine workings within the zone of influence of the operating mine
- Adjacent mines within the zone of influence of the operating mine
- Drill hole information with associated treatment records
- Major water bearing structure(s)/feature(s)

1.6.8 When excavating in areas of limited knowledge, with high inflow risk potential, a programme of probe drilling ahead of the excavation must be in place.

1.6.9 Where the risk of uncontrolled inflow from major structures and/or features, drill holes, flooded historical workings, and/or adjacent mines exists, the following controls must be implemented:

- All drill holes which pose an inflow risk must be plugged/grouted upon completion of service life
b) All drill holes which pose an inflow risk must be clearly identified on relevant mine plans.

c) Major structures and/or features must be portrayed on relevant mine plans and clearly identified as inflow risks.

1.6.10 Where the risk of uncontrolled inflow due to failure of a water retaining pillar exists, the following controls must be implemented:

a) The Ground control management plan must specifically address the design of water retaining pillars (i.e. crown pillar, barrier pillar), provisions for assessing on-going stability (monitoring/inspection) and a clear decision making process for evaluating monitoring data.

b) Water retaining pillar(s) must be designed by a competent person.

1.6.11 Alterations to any water retaining pillar(s) require a risk assessment performed by a competent person or group.

1.6.12 Where the risk of uncontrolled inflow due to failure of a water retaining structure exists, the following controls must be implemented:

a) The location of mine entry points must consider the proximity of water retaining structures and appropriate controls implemented.

b) Surface and underground water retaining structures must be designed by a competent person or group.

c) Procedures must be established for the monitoring and inspection of water retaining structures.

1.6.13 Where the risk of uncontrolled inflow due to surface waters entering the mine exists, the following controls must be implemented:

a) Potential surface water inflow quantities (e.g. 1:100 year event for storms) must be incorporated into the mine pumping system design and water management programmes.

b) Clear Trigger action response plans (TARP) must be in place for storm events.

1.6.14 Where failure of the Mine water management system poses an inundation risk, the system shall:

a) Be designed by a competent person or group.

b) Be designed based on hydrogeological measurements, predicted inflows, and modelling.

c) Be aligned with the current site water balance data.

d) Have continuous monitoring and alarm systems for critical elements of the Mine water management system.

e) Include systems to actively monitor flow that are routinely calibrated.

f) Include procedures for the operation, monitoring, inspection, and maintenance of critical elements of the Mine water management system.

g) Include provision of spares for critical components of the Mine water management system.

h) Provide protection from inundation for electrical installations that are critical to the Mine water management system.

i) Have a reliable power supply. The need for a secondary power feed to the Mine water management system must be evaluated and documented through a formal risk assessment.
D1.7 In-rush solids

Planning

1.7.1 Each operation must identify the potential for in-rush of solids that may be harmful to personnel in the underground environment.

1.7.2 Where there is a risk from the in-rush of solids, the operation will nominate a manager who must establish and implement a Draw control plan. The Draw control plan must:
   a) Incorporate a protocol based on a risk assessment to identify draw points that have a high risk potential for in-rushes
   b) Incorporate a Trigger action response plan (TARP) for extraction from draw points
   c) Be reviewed by an independent, competent person or group every two years or more frequently as determined by a risk assessment, event or when there is a material change to the mine plan

1.7.3 The risk assessment for the in-rush of solids must consider the potential for:
   a) The presence of wet and fine material in draw points
   b) Bulkhead failure that could result in the sudden in-rush of material into working areas where personnel may work or travel
   c) The build-up of cuttings/chippings created by the reaming action of a raise borer
   d) Backfill failure

Implementation and operation

1.7.4 A competent person must conduct periodic surveys of all draw points to monitor:
   a) Changes in moisture content
   b) Fragmentation

1.7.5 Where there is a risk of uncontrolled in-rush of solids from a draw point, the following controls must be implemented:
   a) A method of communicating high risk draw points
   b) A Draw control plan that specifies an extraction rate
   c) Monitoring of draw point extraction rates to reduce the potential for water build up
   d) Controls to prevent unauthorised access to all draw points
   e) Impedance methods to control the flow of muck where there is a high risk of in-rush

1.7.6 There must be a method of stabilising the muck pile before any maintenance or rehabilitation takes place in a draw point.

1.7.7 Where the risk of uncontrolled in-rush of solids from bulkhead failure is identified, the following controls must be implemented:
   a) Bulkheads must be designed and installed by a competent person or group
   b) Active bulkheads must be periodically inspected by a competent person

1.7.8 Where there is a risk of uncontrolled in-rush of solids from ore passes, chutes, or raise boring, the following controls must be implemented:
   a) Ore passes and chutes must be designed by a competent person or group
   b) Controls to prevent unauthorised access
   c) Chute controls are located to ensure the safety of the chute operator
d) Procedures established for the operation, maintenance, and inspection of the **chute** under all operating conditions

e) Procedures and methods established to minimise the potential for the build-up of **raise bore** cuttings during the reaming processes

1.7.9 Where the risk of **in-rush of solids** from backfill failure is identified, the following controls must be implemented:

a) Backfill operations, placement, materials, and procedures must be designed by a **competent person** or group

b) A system of quality control and assurance is established for backfill operations and materials
D1.8 Air blast Planning

1.8.1 Each operation must identify the potential for an **air blast** that may be harmful to personnel in the underground environment.

1.8.2 Where there is a risk of an **air blast**, the operation will nominate a manager who must establish:

   a) A Cave management plan that defines the strategies used in the management of all aspects of the cave, and the coordination of the interrelated elements
   
   b) A system designed to measure, model, or approximate the changing size and three dimensional characteristics of the cave back and muck pile shall be developed and implemented
   
   c) **Air blast** modelling and methodologies used to define air gap parameters and associated risk levels
   
   d) A management system for the geotechnical monitoring system
   
   e) A **Trigger action response plan** (TARP) prescribing the pre-planned response to escalating levels of risk
   
   f) A **Trigger action response plan** (TARP) for defective or malfunctioning geotechnical monitoring systems. Each operation shall have performed geotechnical investigations to determine local and regional rock properties, stresses, and strengths, to facilitate the building of relevant models
   
   g) Suitably qualified and experienced geotechnical engineers to interpret, and develop the data and resultant models

1.8.3 Geotechnical investigation methodologies, models, plans, and recommendations shall be reviewed by a competent third party.

**Implementation and operation**

1.8.4 Cave back propagation and muck pile monitoring systems shall utilise multiple types of geotechnical monitoring systems to facilitate the cross-examination and validation of data.

1.8.5 All openings to the cave, which exist above the **extraction level**, shall have barriers installed to protect workers from hazardous wind velocities.

1.8.6 Protective barriers must be designed, installed, periodically inspected, and maintained by a **competent person** or group.

1.8.7 Underground personnel must be trained in the recognition of signs, indicators, and energies of potential **air blast** events.

1.8.8 The operation must establish real time geotechnical and subsidence monitoring which a **competent person** or group must review.

1.8.9 An independent **competent person** or group must periodically assess results of **geotechnical** and **subsidence** monitoring systems.

1.8.10 Each operation must identify the potential for **subsidence** that may be harmful to personnel underground and/or persons on the surface.

1.8.11 Where there is a risk of surface **subsidence**, the operation must ensure the Cave management plan provides for:

   a) Suitably qualified and experienced geotechnical engineers to interpret relevant data, and develop the resultant subsidence models
   
   b) **Subsidence** zone identification that includes the predicted surface area to be impacted (foot-print) and a suitable factor of safety applied
c) The **subsidence** zone must be proactively provided with remote monitoring capabilities

d) An effective means of securely controlling access to the entire surface area of the **subsidence** zone must be implemented prior to causal mining activities

1.8.12 Pillar system modelling and design must be developed by a **competent person** and reviewed by an independent **competent person** or group.

1.8.13 A **competent person** must design pillar extraction activities.

1.8.14 Procedures must be established for the regular inspection and monitoring of pillars to ensure their integrity is maintained.

1.8.15 Pillar alterations resulting in a reduction of **factors of safety** must be designed by a **competent person** and be subject to management of change process.

1.8.16 To control Cascading Pillar Failure; compromised pillar integrity must be evaluated for stresses which may be transferred and applied to neighbouring pillars resulting in loading beyond their design capacity.

1.8.17 Roadways/Haulage-ways/Headings must be inspected on a regular basis and maintained as necessary to protect the integrity of pillars.

1.8.18 A **competent person** shall monitor the **goaf** to ensure failure is occurring as designed.

1.8.19 A **Trigger action response plan (TARP)** prescribing the pre-planned response to escalating levels of risk will be developed and implemented to respond to hazards associated with **goaf** failure and corresponding air blast potentials.

1.8.20 Measures to induce collapse in a non-failing **goaf** must be implemented as soon as practicable to reduce the magnitude of any potential **air blast**.
D1.9 Explosive agents

Planning

1.9.1 Each operation that manufactures, stores, handles, transports or uses explosives must have a nominated manager responsible for the implementation of this standard.

1.9.2 The nominated manager must ensure that risk assessments are performed for all aspects of managing, manufacturing, storing, handling, transporting and using explosives on site and approve these assessments.

1.9.3 The nominated manager must arrange for the development of and approve an Explosives management plan that:

   a) Is designed by a competent person
   b) Is reviewed by an independent competent person or group every two years or more frequently as determined by risk assessment
   c) Includes procedures to control the risks associated with manufacturing, transport, storage, handling, use and disposal of explosives
   d) Establishes exclusion zones to control risk of ignition from extraneous sources e.g. electricity, lightning, projectiles, fire, and impact by mobile equipment
   e) Establishes controls that restrict unauthorised access to explosives
   f) Includes procedures for explosives inventory management, control and reconciliations, with records kept for a minimum of two years
   g) Includes an assessment and annual review by a competent person of the likely footprint from an unplanned explosion at an explosive manufacturing or storage facility.
   h) Establishes controls to mitigate the potential effects and impacts an explosion may have on site infrastructure including, but not limited to:
      • Commonly used transport routes
      • Permanently and temporarily occupied buildings such as:
        ▪ Offices
        ▪ Workshops
        ▪ Control rooms
   i) Includes procedures to control the risk of explosions from activities associated with maintenance and servicing of plant and equipment that is used to manufacture, store, transport or handle explosives
   j) Includes procedures to control the risks of explosions from lightning, dust storms or other significant natural events
   k) Establishes the competency and authorisation requirements for all activities associated with explosives
   l) Establishes an "explosives awareness" training programme for all personnel who may:
      ▪ Come in contact with explosives
      ▪ Be in the vicinity of a blast zone

1.9.4 Explosives manufacturing and storage facilities must be designed and annually audited by a competent person or group

Implementation and operation

1.9.5 Vehicles and other conveyances used to transport explosives must:
   a) Display signage indicating that explosives are being carried
   b) Be under the direct supervision of an authorised person (unless parked in a designated and secure blast area or explosive compound)
1.9.6 During transport; packaged **explosives**, high **explosives** and initiating **explosives** must:
   a) Be stowed in lockable receptacles, which are clearly signed to indicate the nature of the contents
   b) Be secured in a manner such that they will remain in a stable position
   c) Not be transported with any non-compatible substances, e.g. dangerous goods, chlorate based products or fire risk substances

1.9.7 Initiating **explosives** must not be stowed in the same airspace as packaged or high **explosives**.

1.9.8 All operations that conduct blasting must develop plans and procedures for charging, blasting and reporting processes.

1.9.9 Blast sites (loaded blast holes/patterns) must be adequately demarcated and made secure to prevent unauthorised or inadvertent access.

1.9.10 The location of blast sites must be communicated to personnel who work or travel in the vicinity of the blast site.

1.9.11 Procedures must be in place that ensures drill holes will not intersect previously charged blast holes.

1.9.12 **Loading** of **explosives** must be under the direct supervision of an authorised person.

1.9.13 Where **non routine blasting** is carried out, specific procedures must be established and implemented to control the risks

1.9.14 All operations that conduct blasting must develop and implement a blast firing procedure that includes:
   a) The appointment of a qualified blaster/shot-firer as the person responsible for the blast
   b) A process for establishing a blast clearance zone based on a **risk assessment** that takes into account the impact for:
      • The immediate blast area
      • Assets outside the immediate blast zone area including: o People, o Plant/equipment, o Facilities/infrastructure o Ventilation pathways etc.
   c) An assessment of the interactions/impacts on the following, which are outside the blast clearance zone:
      • People
      • Plant/equipment
      • Facilities/infrastructure
      • Ventilation pathways etc.
   d) A process for notifying, clearing, securing, initiating and subsequently reentering, the blasting area
   e) A process for identifying, addressing, reporting, and investigation of misfires