

MOSH - INDUSTRY DUST RISK BOWTIE ANALYSIS
Gold - Crystalline Silica (Underground)

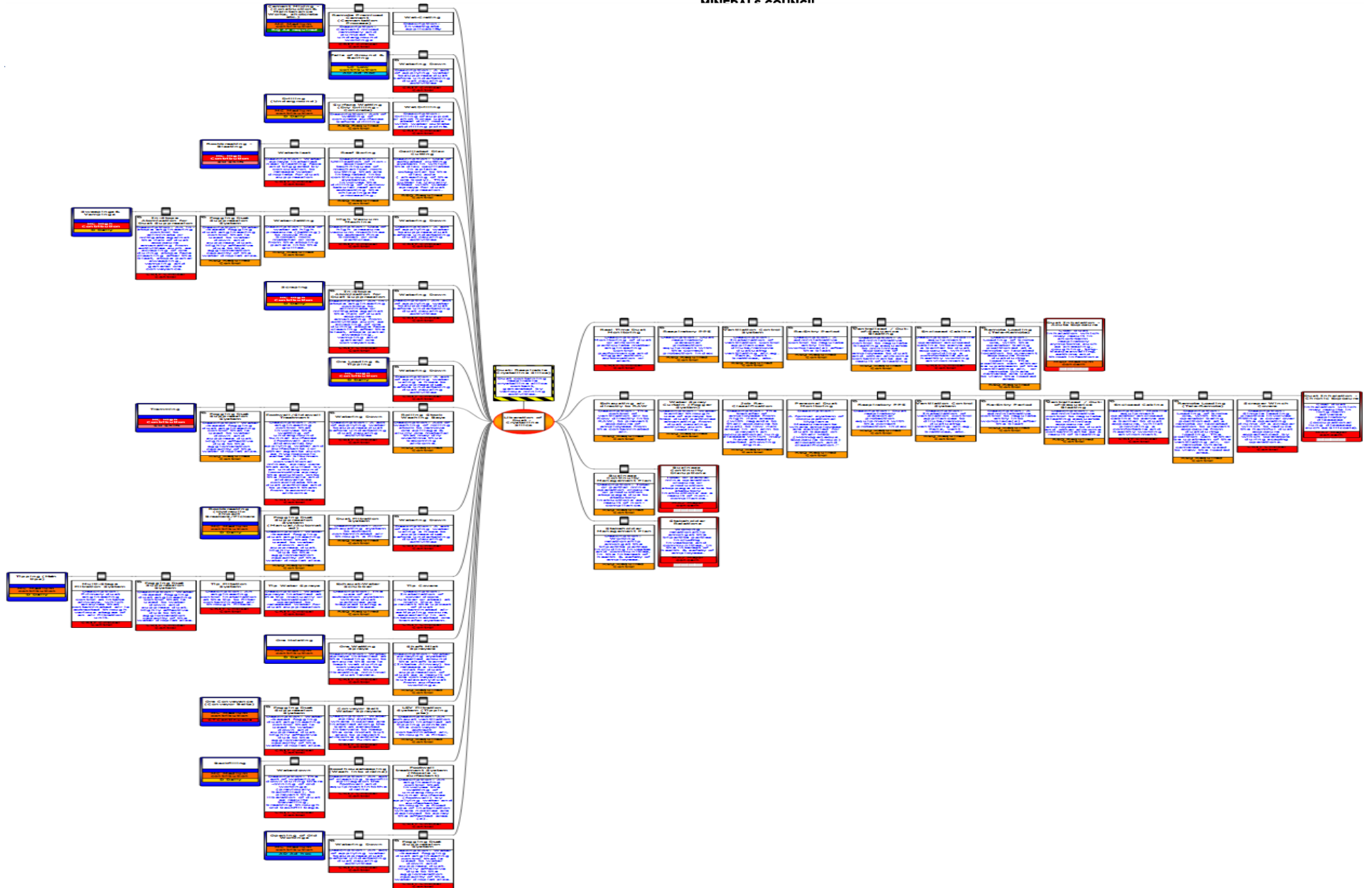


MOSH - INDUSTRY DUST RISK BOWTIE ANALYSIS

[Hazard Dust- Respirable Crystalline Silica](#)

Hazard name	Dust- Respirable Crystalline Silica)
BowTie Group	MOSH - INDUSTRY DUST RISK BOWTIE ANALYSIS
Top event	Liberation of Dust - Crystalline Silica
Affects	Health

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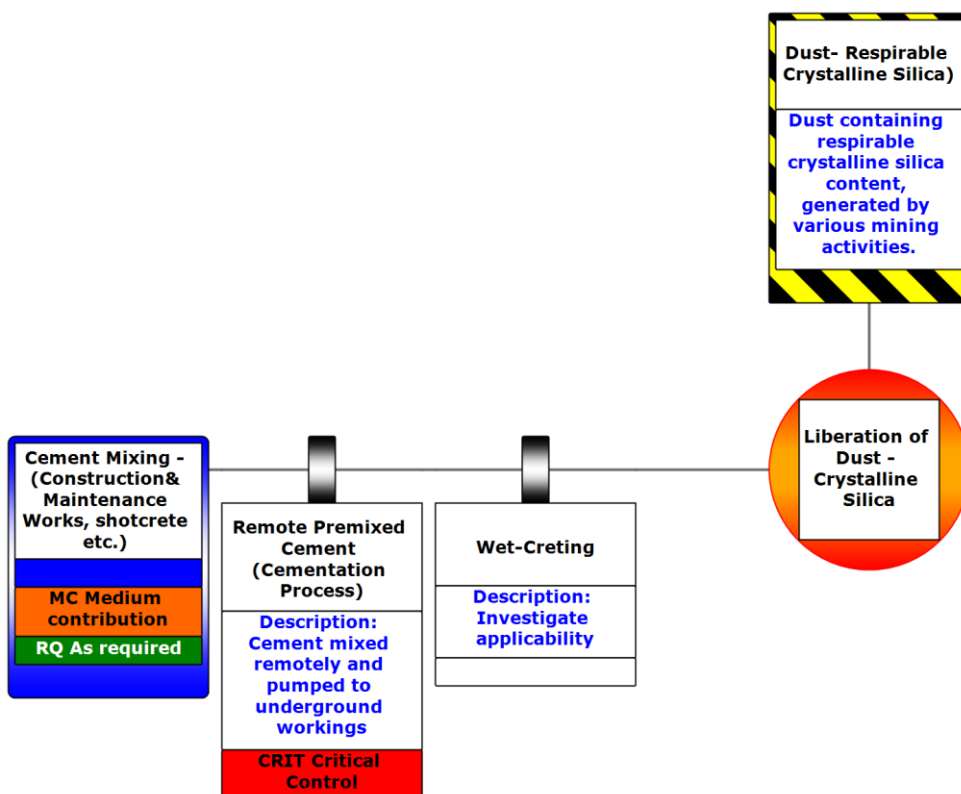
Hazard Description

Dust containing respirable crystalline silica content, generated by various mining activities.

Threats

Threat: Cement Mixing - (Construction & Maintenance Works, shotcrete etc.)

Any construction done for preparation or maintenance of mining work includes the application of cementitious coating of the sidewall and hanging wall, in order to prevent loose rock from falling or scaling.



Barrier: Remote Premixed Cement (Cementation Process)

Barrier Category	System
Barrier Type	Substitution
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

Cement is mixed remotely and pumped to underground workings.

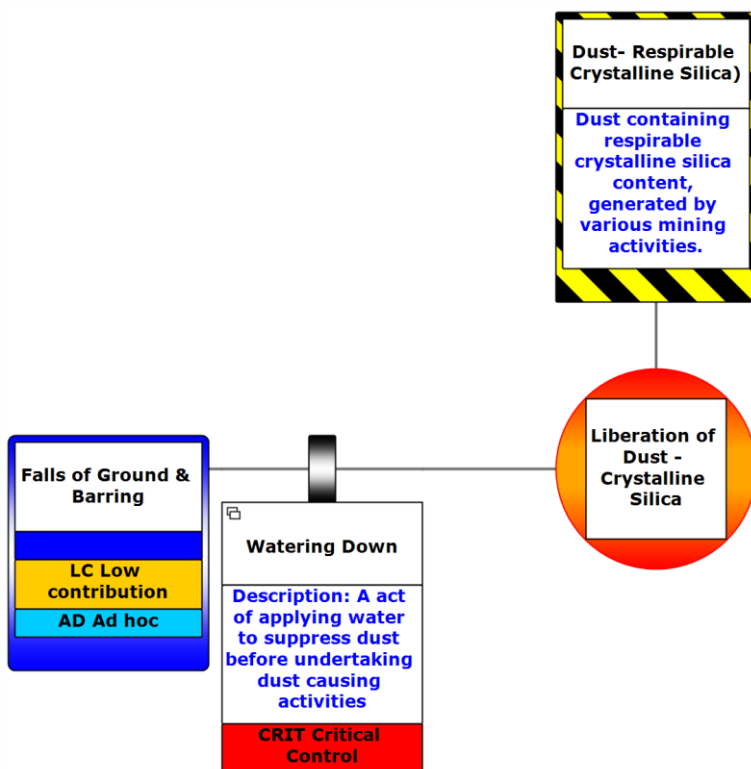
Barrier: Wet-Creting

Description:

Investigate applicability.

Threat: Falls of Ground & Barring

The removal or falling of loose slabs of rock from roofs and walls of excavations after blasting or using a pinch bar. The falls of ground can occur due to seismicity, poor ground conditions, rock fragmentation & lack of ground support etc. Barring is done to remove the fall of ground hazard posed by these loose blocks of rock.



Barrier: Watering Down

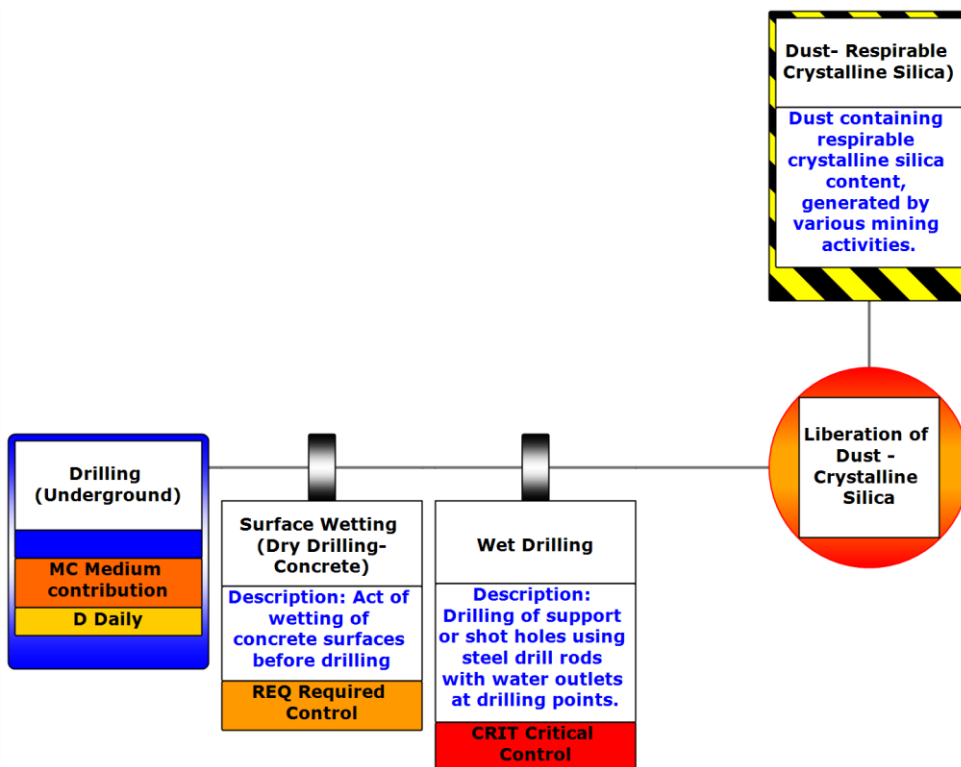
Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Miner
Criticality	CRIT Critical Control

Description:

An act of applying water to suppress dust before undertaking dust causing activities.

Threat: Drilling (Underground)

A mining process where rock drills are used for making holes for placing dynamite or other explosives in rock blasting, but also for ground support installation.



Barrier: Surface Wetting (Dry Drilling-Concrete)

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Miner
Criticality	REQ Required Control

Description:

Act of wetting of concrete surfaces before drilling

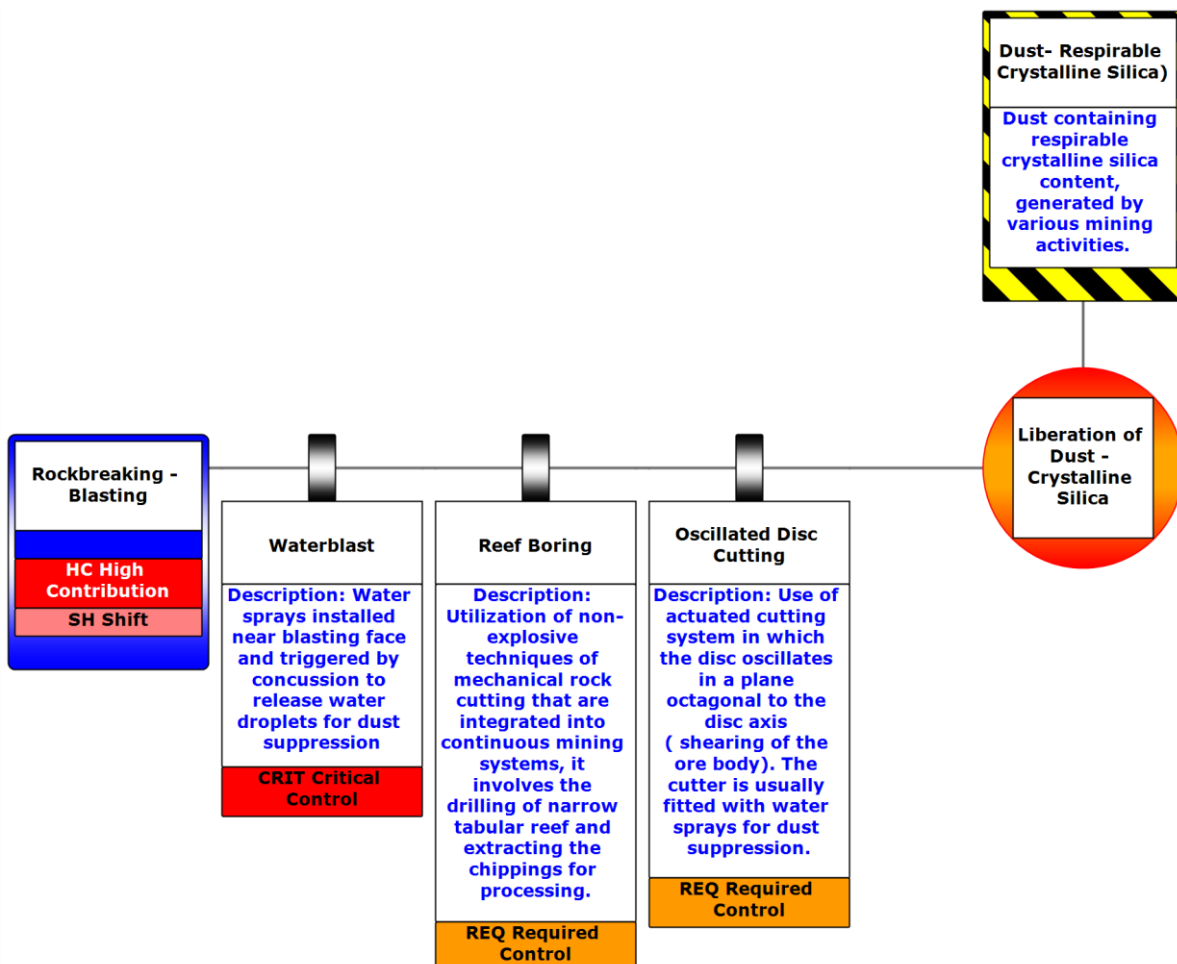
Barrier: Wet Drilling Description

Drilling of support or shot holes using steel drill rods with water outlets at drilling points.

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	++ Very Good
Accountable	Miner
Criticality	CRIT Critical Control

Threat: Rock breaking - Blasting

Fragmentation of the rock or ore body through use of explosives during the mining process (including secondary blasting) and often releases dust and other associated gases.



Barrier: Waterblast

Barrier Category	Object
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Miner
Criticality	CRIT Critical Control

Description:

Water sprays installed near blasting face and triggered by concussion to release water droplets for dust suppression.

Barrier: Reef Boring

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Operations Manager
Criticality	REQ Required Control

Description:

Utilization of non-explosive techniques of mechanical rock cutting that are integrated into continuous mining systems, it involves the drilling of narrow tabular reef and extracting the chippings for processing.

Barrier: Oscillated Disc Cutting

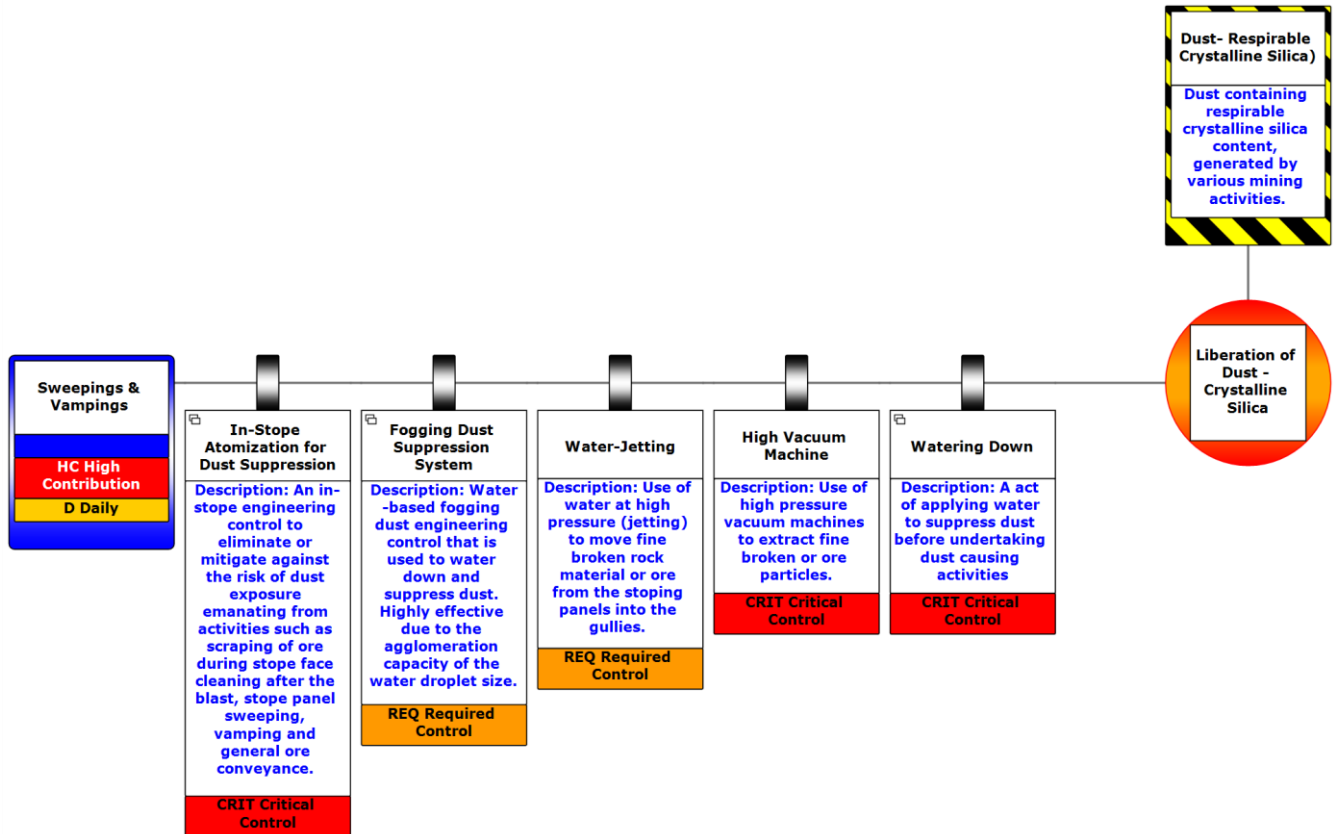
Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

Use of actuated cutting system in which the disc oscillates in a plane octagonal to the disc axis (shearing of the ore body). The cutter is usually fitted with water sprays for dust suppression.

Threat: Sweepings & Vampings

Removal of all remaining broken ore left behind after scraping activity. This may commence during the stopping phase and continues after stopping has been completed. High-powered vacuum machines or manually using shovels and/or steel brushes to sweep ore left behind.



Barrier: In-Stope Atomization for Dust Suppression

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	++ Very Good
Accountable	Miner
Criticality	CRIT Critical Control

Description:

An in-stope engineering control to eliminate or mitigate against the risk of dust exposure emanating from activities such as scraping of ore during stope face cleaning after the blast, stope panel sweeping, vamping and general ore conveyance.

Barrier: Fogging Dust Suppression System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Operations
Criticality	REQ Required Control

Description:

Water-based fogging dust engineering control that is used to water down and suppress dust. Highly effective due to the agglomeration capacity of the water droplet size.

Verification:

Pre-work inspections (water pressure testing, nozzles condition inspections, water leakages, system operability)

Barrier: Water-Jetting

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

Use of water at high pressure (jetting) to move fine broken rock material or ore from the stoping panels into the gullies.

Barrier: High Vacuum Machine

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	++ Very Good
Criticality	CRIT Critical Control

Description:

Use of high-pressure vacuum machines to extract fine broken or ore particles.

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Barrier: Watering Down

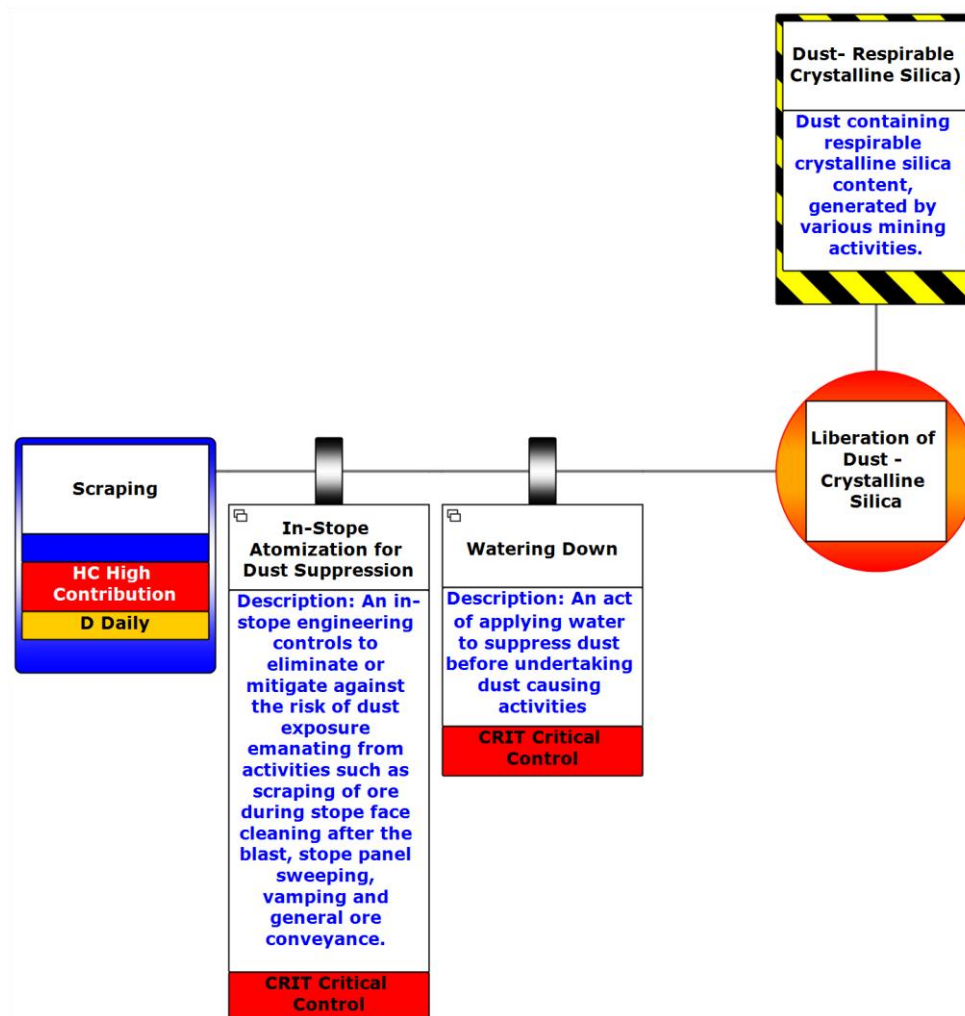
Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Operations
Criticality	CRIT Critical Control

Description:

An act of applying water to suppress dust before undertaking dust causing activities.

Threat: Scraping

An ore conveyance process which includes movement of blasted rock from mining areas. using a winch.



Barrier: In-Stope Atomization for Dust Suppression

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

An in-stope engineering controls to eliminate or mitigate against the risk of dust exposure emanating from activities such as scraping of ore during stope face cleaning after the blast, stope panel sweeping, vamping and general ore conveyance.

Barrier: Watering Down

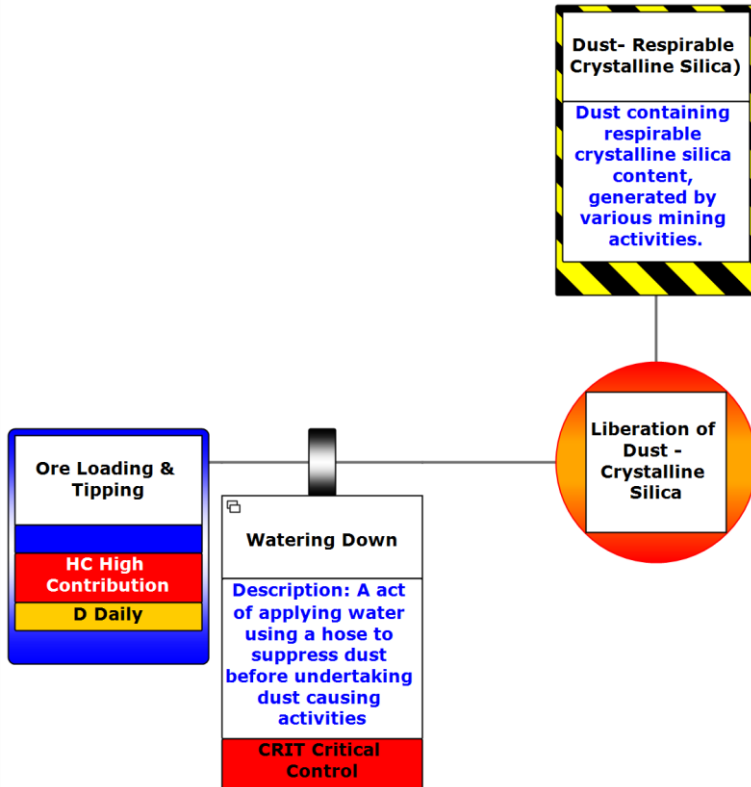
Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Operations
Criticality	CRIT Critical Control

Description:

An act of applying water to suppress dust before undertaking dust causing activities.

Threat: Ore Loading & Tipping

Loading of blasted rock from workings, into a tramming cart (Hooper)/dump truck using a mechanical loader/LHD. This may include the tipping of ore at tipping points.



Barrier: Watering Down

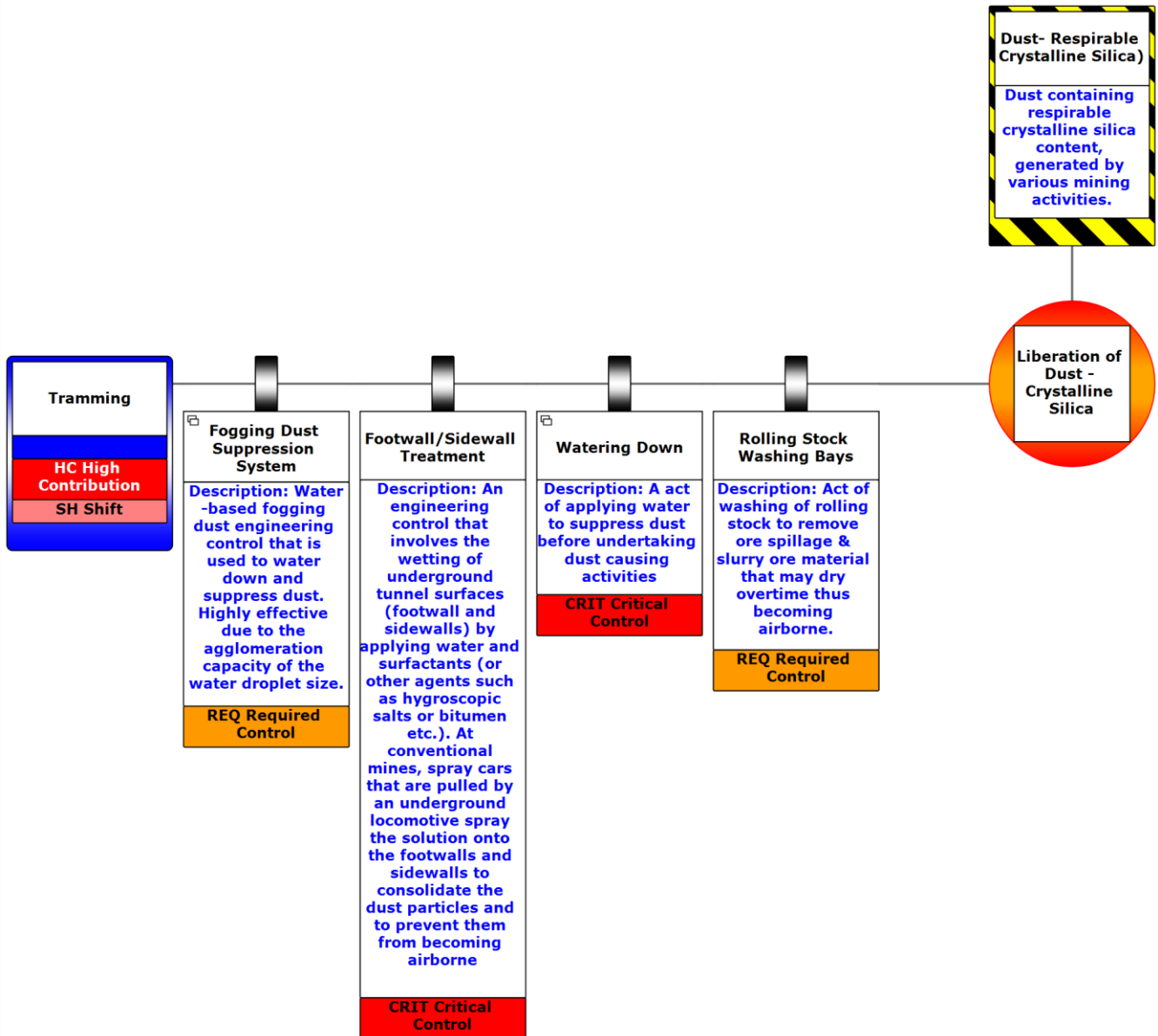
Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Shift Supervisor
Criticality	CRIT Critical Control

Description:

An act of applying water using a hose to suppress dust before undertaking dust causing activities.

Threat: Trammig

A process that involves loading, transporting and dumping of materials in mines. Trammig equipment may include locomotives (trains) running on rails, haulage vehicles such as trucks and LHD vehicles (also known as scoop trams) explosive handling equipment.



Barrier: Fogging Dust Suppression System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

Water-based fogging dust engineering control that is used to water down and suppress dust. Highly effective due to the agglomeration capacity of the water droplet size.

Verification:

Pre-work inspections (water pressure testing, nozzles condition inspections, water leakages, system operability)

Barrier: Footwall/Sidewall Treatment

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Operations Manager
Criticality	CRIT Critical Control

Description:

An engineering control that involves the wetting of underground tunnel surfaces (footwall and sidewalls) by applying water and surfactants (or other agents such as hygroscopic salts or bitumen etc.). At conventional mines, spray cars that are pulled by an underground locomotive spray the solution onto the footwalls and sidewalls to consolidate the dust particles and to prevent them from becoming airborne.

Barrier: Watering Down

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Shift Supervisor
Criticality	CRIT Critical Control

Description:

An act of applying water to suppress dust before undertaking dust causing activities.

Barrier: Rolling Stock Washing Bays

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	++ Very Good

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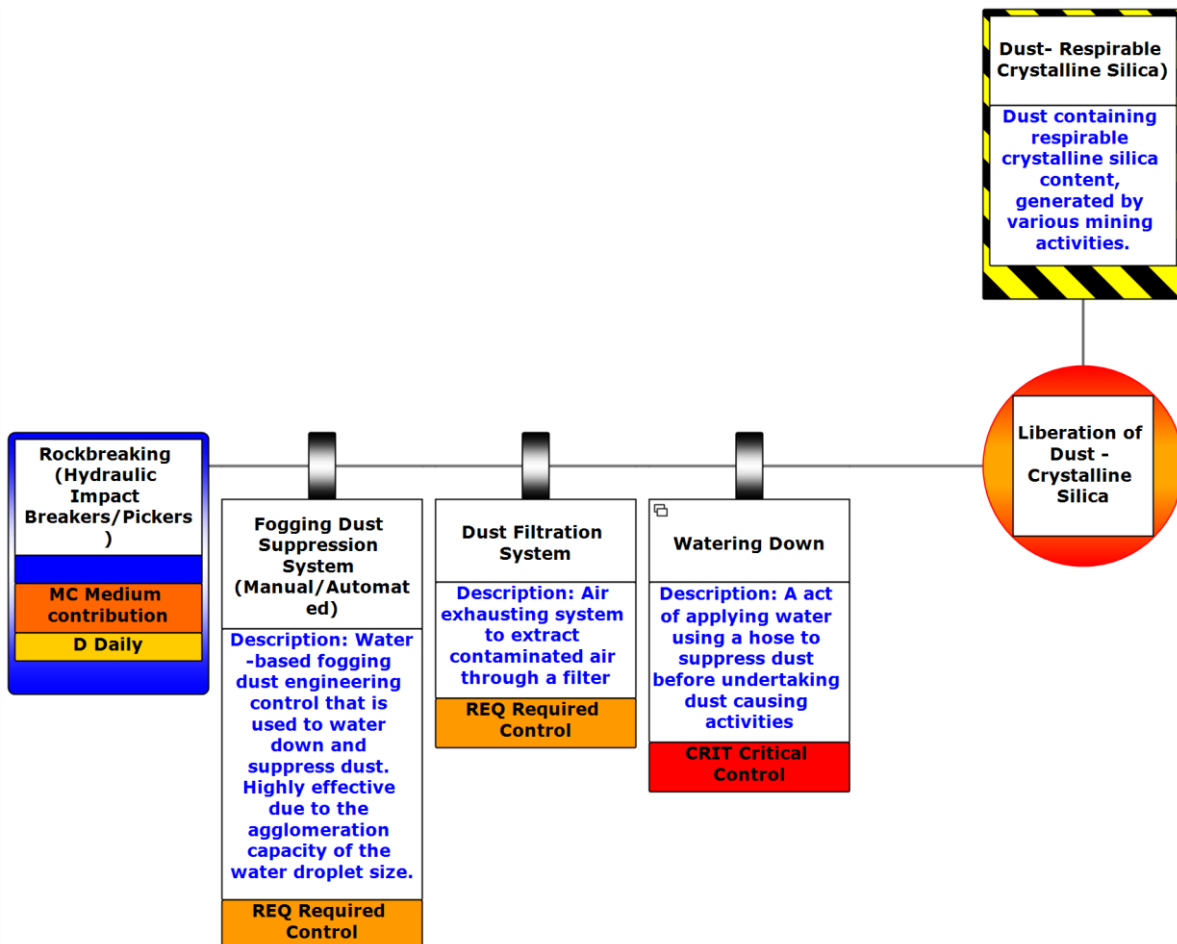
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

Act of washing of rolling stock to remove ore spillage & slurry ore material that may dry overtime thus becoming airborne.

Threat: Rock breaking (Hydraulic Impact Breakers/Pickers)

Breaking of big rocks at tips to allow their access into the tip for loading purposes.



Barrier: Fogging Dust Suppression System (Manual/Automated)

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good

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Accountable	Operations Manager
Criticality	REQ Required Control

Description:

Water-based fogging dust engineering control that is used to water down and suppress dust. Highly effective due to the agglomeration capacity of the water droplet size.

Verification:

Pre-work inspections (water pressure testing, nozzles condition inspections, water leakages, system operability)

Barrier: Dust Filtration System

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

An air exhausting system to extract contaminated air through a filter.

Barrier: Watering Down

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Shift Supervisor
Criticality	CRIT Critical Control

Description:

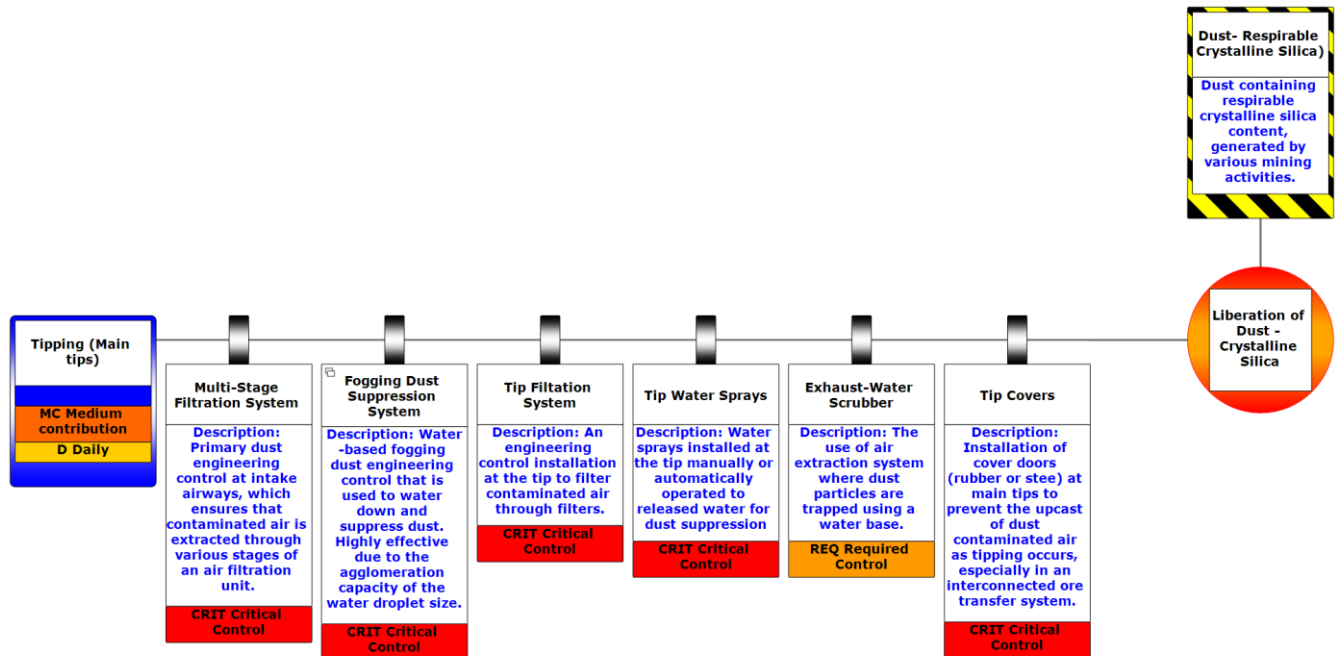
An act of applying water using a hose to suppress dust before undertaking dust causing activities.

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Threat: Tipping (Main tips)

An ore conveyance process which includes movement of blasted ore from mining stopes ore-passes to the shaft ore transfer system, through tipping the ore at various tipping points.



Barrier: Multi-Stage Filtration System

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

Primary dust engineering control at intake airways, which ensures that contaminated air is extracted through various stages of an air filtration unit.

Verification:

Pre-use inspection

Maintenance (predictive & scheduled)

Barrier: Fogging Dust Suppression System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	? Unknown
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

Water-based fogging dust engineering control that is used to water down and suppress dust. Highly effective due to the agglomeration capacity of the water droplet size.

Verification:

Pre-work inspections (water pressure testing, nozzles condition inspections, water leakages, system operability)

Barrier: Tip Filtration System

Barrier Category	Act
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

An engineering control installation at the tip to filter contaminated air through filters.

Barrier: Tip Water Sprays

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

Water sprays installed at the tip manually or automatically operated to release water for dust suppression.

Barrier: Exhaust-Water Scrubber

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	REQ Required Control

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Description:

The use of air extraction system where dust particles are trapped using a water base.

Barrier: Tip Covers

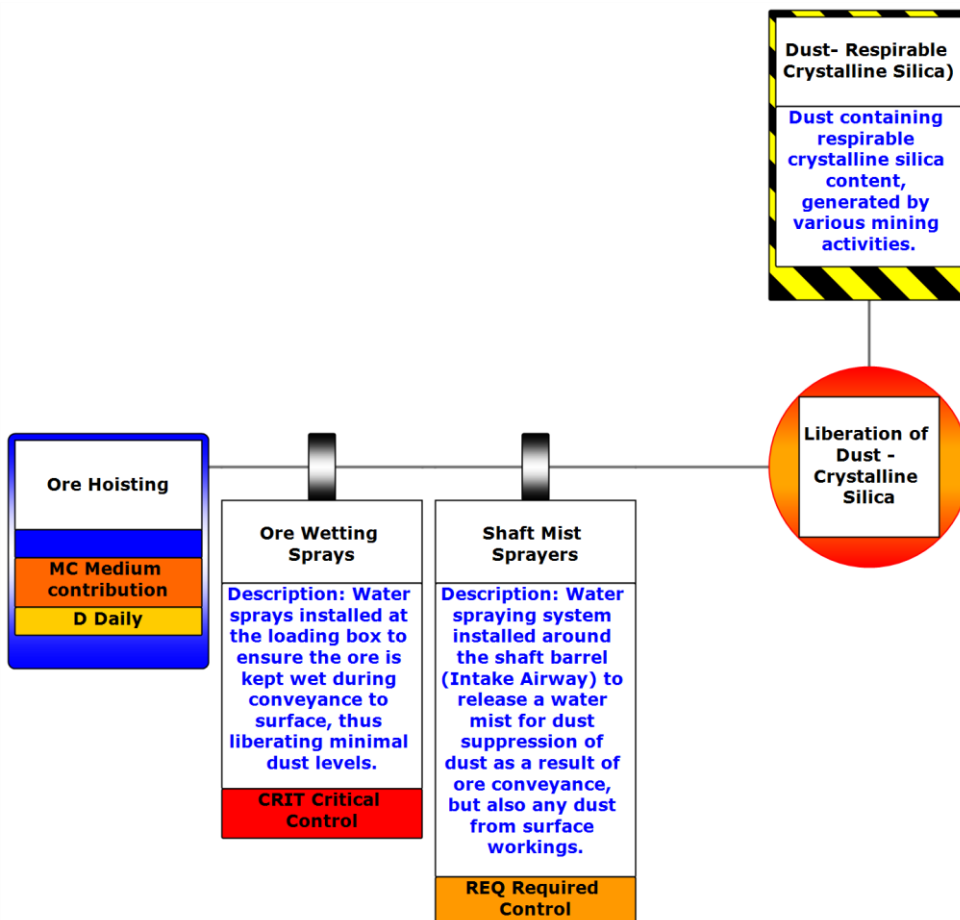
Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

Installation of cover doors (rubber or steel) at main tips to prevent the upcast of dust contaminated air as tipping occurs, especially in an interconnected ore transfer system.

Threat: Ore Hoisting

Conveyance of broken ore from main shaft loading box, through the main shaft (man & material Shaft) to the surface silo belts.



Barrier: Ore Wetting Sprays

Barrier Category		Object
Barrier Type		Engineering Control
Effectiveness		+ Good
Accountable		Mine Overseer
Criticality		CRIT Critical Control

Description:

Water sprays installed at the loading box to ensure the ore is kept wet during conveyance to surface, thus liberating minimal dust levels.

Barrier: Shaft Mist Sprayers

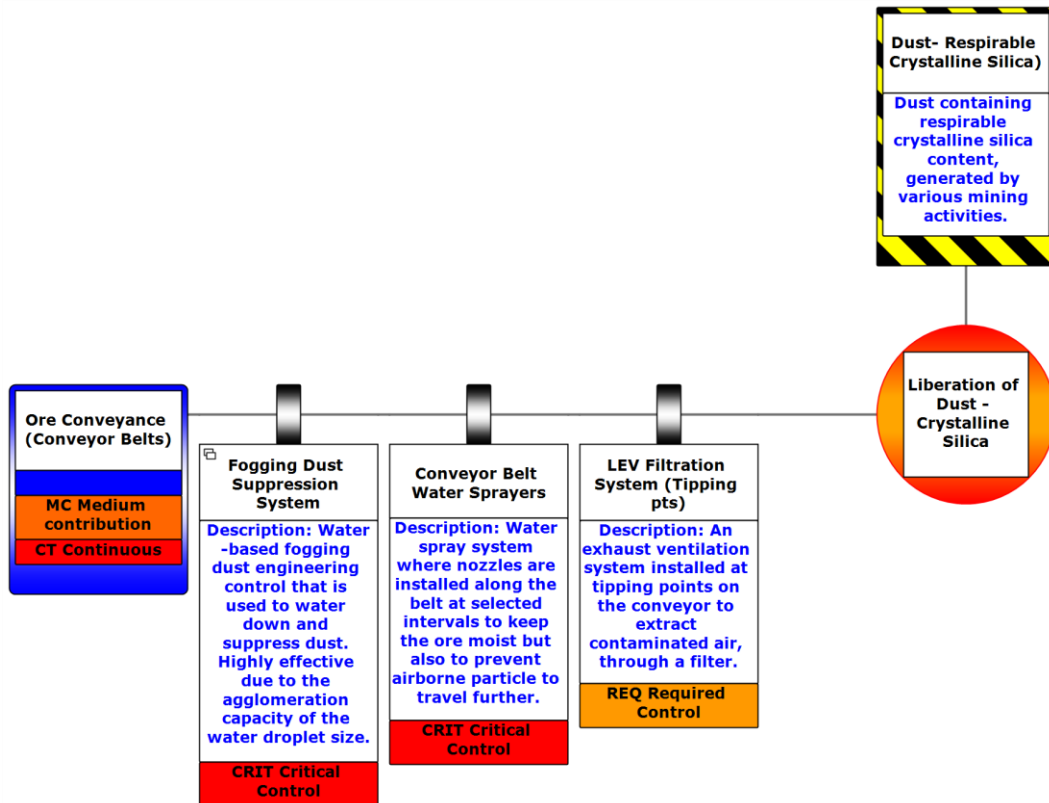
Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

A water spraying system is installed around the shaft barrel (Intake Airway) to release a water mist for dust suppression of dust as a result of ore conveyance, but also any dust from surface workings.

Threat: Ore Conveyance (Conveyor Belts)

The movement of ore from tips to shaft bunkers through use of conveyor belts



Barrier: Fogging Dust Suppression System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

Water-based fogging dust engineering control that is used to water down and suppress dust. Highly effective due to the agglomeration capacity of the water droplet size.

Verification:

Pre-work inspections (water pressure testing, nozzles condition inspections, water leakages, system operability)

Barrier: Conveyor Belt Water Sprayers

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

A water spray system where nozzles are installed along the belt at selected intervals to keep the ore moist but also to prevent airborne particles from traveling further.

Barrier: LEV Filtration System (Tipping pts)

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	REQ Required Control

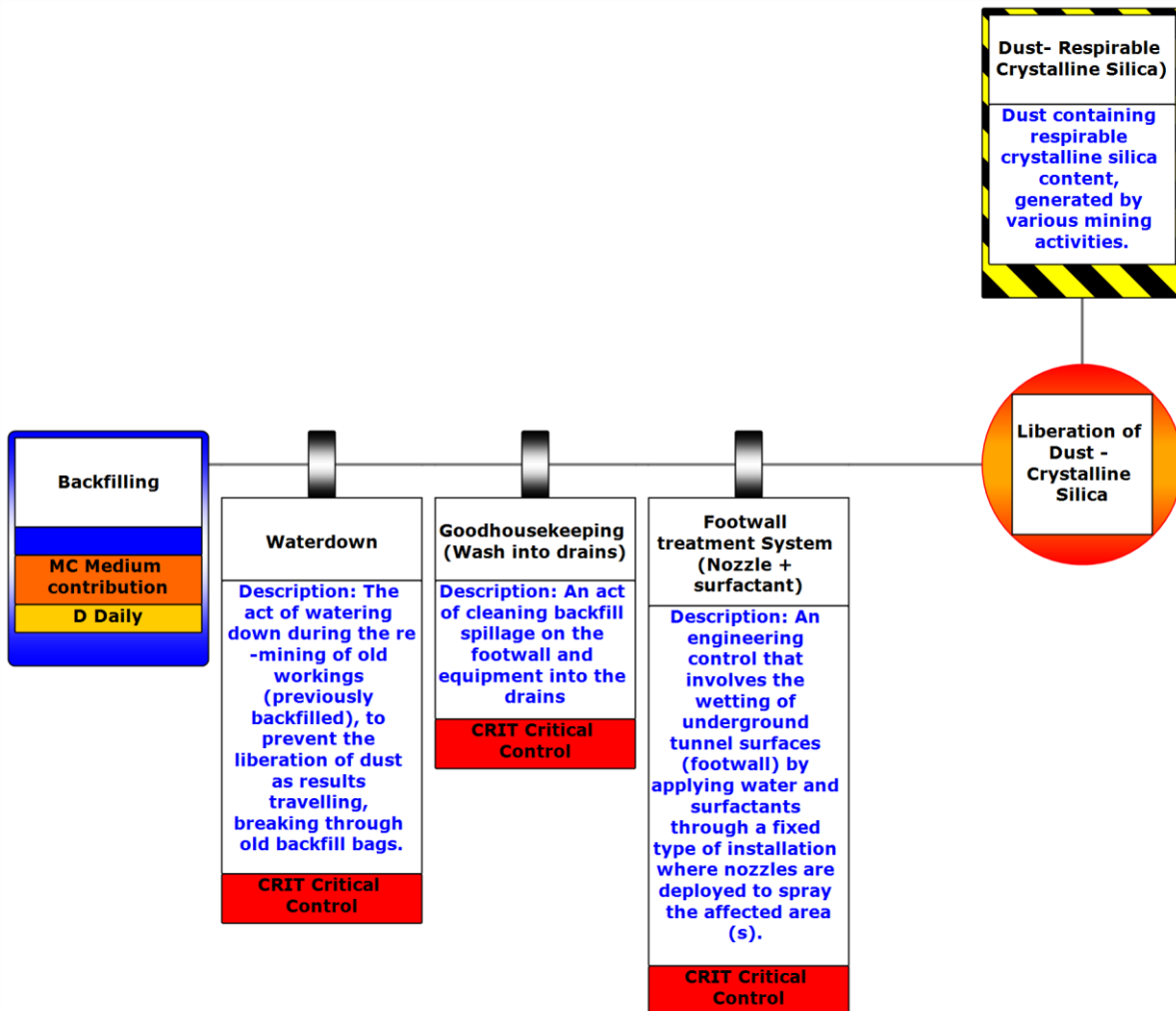
Description:

An exhaust ventilation system installed at tipping points on the conveyor to extract contaminated air, through a filter.

Threat: Backfilling

Cementous filling of in stope back areas for support and ventilation purposes.

- Backfill bags for support.
- Flushing
- Spillages
- Long hole stopes (Re-mining thru backfill)



Barrier: Waterdown

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

The act of watering down during the re-mining of old workings (previously backfilled), to prevent the liberation of dust as results travelling, breaking through old backfill bags.

Barrier: Good housekeeping (Wash into drains)

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

An act of cleaning backfill spillage on the footwall and equipment into the drains.

Barrier: Footwall treatment System (Nozzle + surfactant)

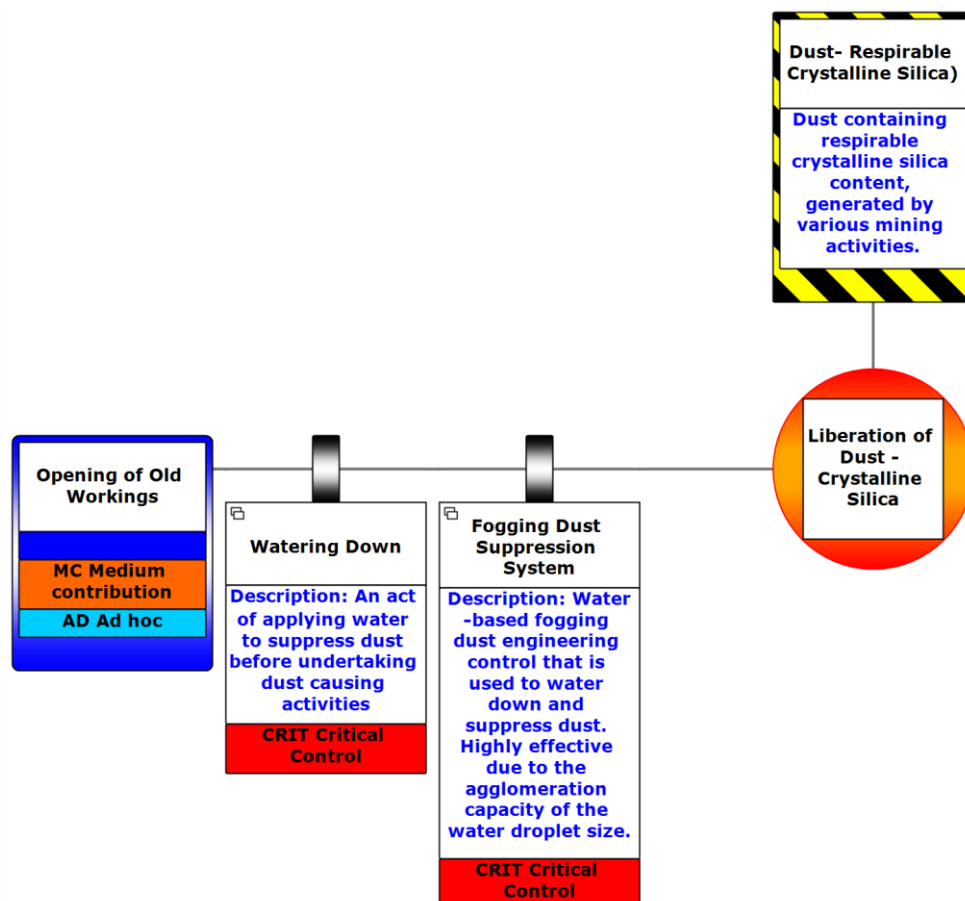
Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

An engineering control that involves the wetting of underground tunnel surfaces (footwall) by applying water and surfactants through a fixed type of installation where nozzles are deployed to spray the affected area(s).

Threat: Opening of Old Workings

Opening of old workplaces as a result of re-mining or reclamation may result in dust liberation due to travelling and transportation of materials (agitation of settled dust).



Barrier: Watering Down

Barrier Category	Act
Barrier Type	Elimination
Effectiveness	+ Good
Accountable	Operations
Criticality	CRIT Critical Control

Description:

An act of applying water to suppress dust before undertaking dust causing activities.

Barrier: Fogging Dust Suppression System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

Water-based fogging dust engineering control that is used to water down and suppress dust. Highly effective due to the agglomeration capacity of the water droplet size.

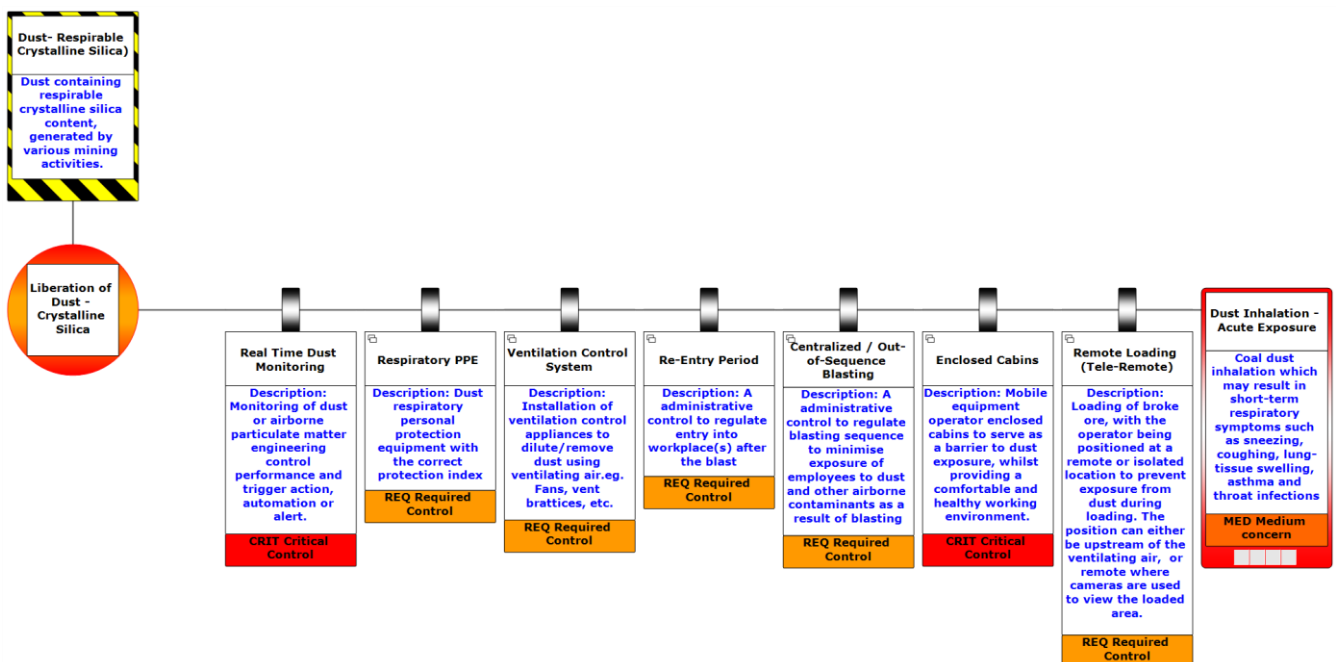
Verification:

Pre-work inspections (water pressure testing, nozzles condition inspections, water leakages, system operability)

Consequences

Consequence: Dust Inhalation - Acute Exposure

Coal dust inhalation which may result in short-term respiratory symptoms such as sneezing, coughing, lung-tissue swelling, asthma and throat infections



Barrier: Real Time Dust Monitoring

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

Monitoring of dust or airborne particulate matter engineering control performance and trigger action, automation or alert.

Barrier: Respiratory PPE

Barrier Category	Object
Barrier Type	Personal Protective Equipment
Effectiveness	+ Good
Accountable	HSE Department
Criticality	REQ Required Control

Description:

Dust respiratory personal protection equipment with the correct protection index

Verification:

- Supervision
- Visible Felt Leadership routines.
- PPE withdrawal reports

Barrier: Ventilation Control System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	++ Very Good
Accountable	Group Environmental Engineer
Criticality	REQ Required Control

Description:

Installation of ventilation control appliances to dilute/remove dust using ventilating air.eg. Fans, vent brattices, etc.

Barrier: Re-Entry Period

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Ventilation and Occupational Hygiene
Criticality	REQ Required Control

Description:

An administrative control to regulate entry into workplace(s) after the blast.

Barrier: Centralized / Out-of-Sequence Blasting

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Operations Manager
Criticality	REQ Required Control

Description:

An administrative control to regulate blasting sequence to minimize exposure of employees to dust and other airborne contaminants as a result of blasting.

Barrier: Enclosed Cabins

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

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Gold - Crystalline Silica (Underground)



Description:

Mobile equipment operators enclosed cabins to serve as a barrier to dust exposure, whilst providing a comfortable and healthy working environment.

Barrier: Remote Loading (Tele-Remote)

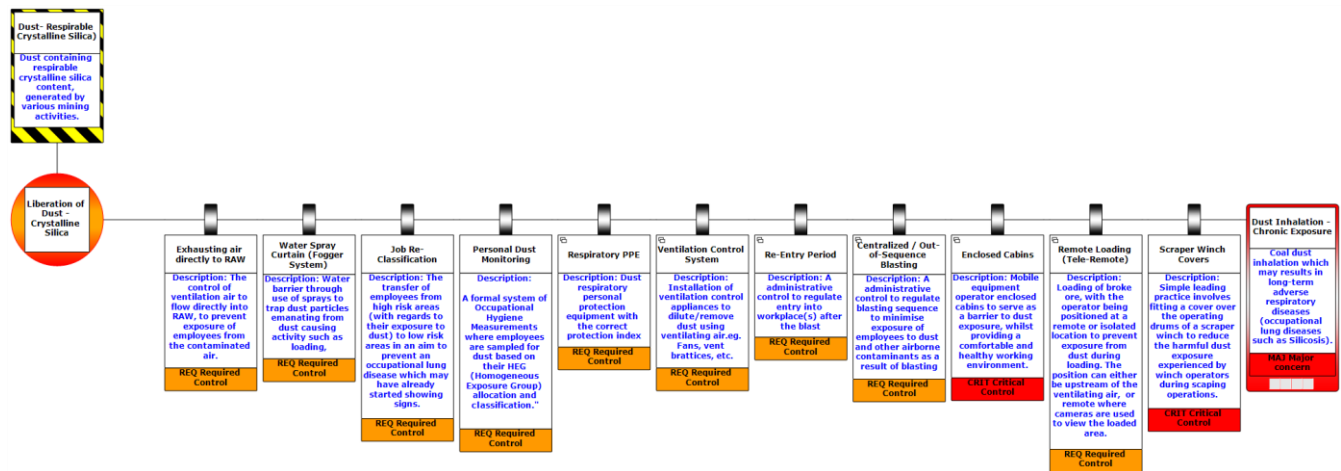
Barrier Category	Act
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Miner
Criticality	REQ Required Control

Description:

Loading of broke ore, with the operator being positioned at a remote or isolated location to prevent exposure from dust during loading. The position can either be upstream of the ventilating air, or remote where cameras are used to view the loaded area.

Consequence: Dust Inhalation - Chronic Exposure

Coal dust inhalation may result in long-term adverse respiratory diseases (occupational lung diseases such as Silicosis).



Barrier: Exhausting air directly to RAW

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Group Environmental Engineer
Criticality	REQ Required Control

Description:

The control of ventilation air to flow directly into RAW, to prevent exposure of employees from the contaminated air.

Barrier: Water Spray Curtain (Fogger System)

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Mine Overseer
Criticality	REQ Required Control

Description:

Water barrier through use of sprays to trap dust particles emanating from dust causing activity such as loading,

Barrier: Job Re-Classification

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Human Resources
Criticality	REQ Required Control

Description:

The transfer of employees from high-risk areas (with regards to their exposure to dust) to low-risk areas with the aim of preventing an occupational lung disease which may have already started showing signs.

Barrier: Personal Dust Monitoring

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Ventilation and Occupational Hygiene
Criticality	REQ Required Control

Description:

A formal system of Occupational Hygiene Measurements where employees are sampled for dust based on their HEG (Homogeneous Exposure Group) allocation and classification."

Barrier: Respiratory PPE

Barrier Category	Object
Barrier Type	Personal Protective Equipment
Effectiveness	++ Very Good
Accountable	HSE Department
Criticality	REQ Required Control

Description:

Dust respiratory personal protection equipment with the correct protection index

Verification:

- Supervision
- Visible Felt Leadership routines.

Barrier: Ventilation Control System

Barrier Category	System
Barrier Type	Engineering Control
Effectiveness	++ Very Good
Accountable	Ventilation and Occupational Hygiene
Criticality	REQ Required Control

Description:

Installation of ventilation control appliances to dilute/remove dust using ventilating air.eg. Fans, vent brattices, etc.

Barrier: Re-Entry Period

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Ventilation and Occupational Hygiene
Criticality	REQ Required Control

Description:

An administrative control to regulate entry into workplace(s) after the blast.

Barrier: Centralized / Out-of-Sequence Blasting

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Operations Manager
Criticality	REQ Required Control

Description:

An administrative control to regulate blasting sequence to minimize exposure of employees to dust and other airborne contaminants as a result of blasting

Barrier: Enclosed Cabins

Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	+ Good
Accountable	Engineer
Criticality	CRIT Critical Control

Description:

Mobile equipment operators enclosed cabins to serve as a barrier to dust exposure, whilst providing a comfortable and healthy working environment.

Barrier: Remote Loading (Tele-Remote)

Barrier Category	Act
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Operations Manager
Criticality	REQ Required Control

Description:

Loading of broke ore, with the operator being positioned at a remote or isolated location to prevent exposure from dust during loading. The position can either be upstream of the ventilating air, or remote where cameras are used to view the loaded area.

Barrier: Scraper Winch Covers

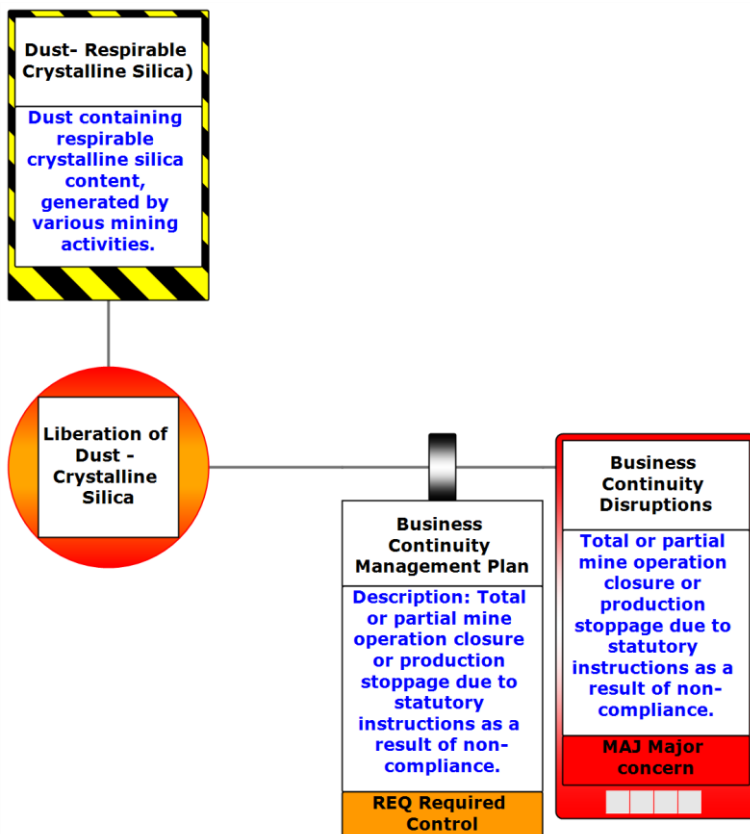
Barrier Category	Object
Barrier Type	Engineering Control
Effectiveness	++ Very Good
Accountable	Mine Overseer
Criticality	CRIT Critical Control

Description:

Simple leading practice involves fitting a cover over the operating drums of a scraper winch to reduce the harmful dust exposure experienced by winch operators during scraping operations.

Consequence: Business Continuity Disruptions

Total or partial mine operation closure or production stoppage due to statutory instructions as a result of non-compliance.



Barrier: Business Continuity Management Plan

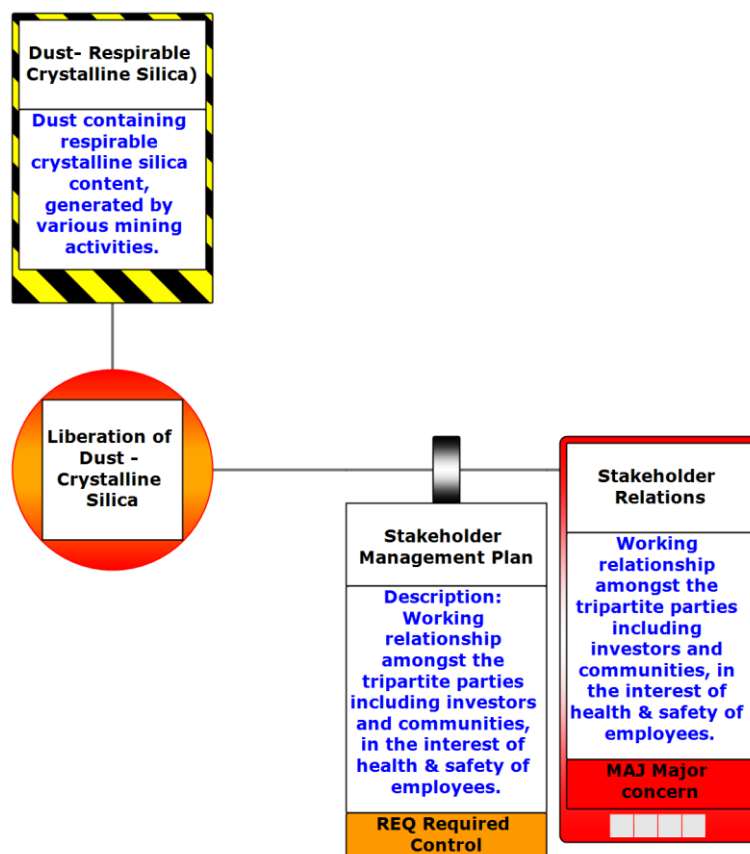
Barrier Category	System
Barrier Type	Administrative
Effectiveness	- Poor
Accountable	Corporate
Criticality	REQ Required Control

Description:

Total or partial mine operation closure or production stoppage due to statutory instructions as a result of non-compliance.

Consequence: Stakeholder Relations

Working relationship amongst the tripartite parties including investors and communities, in the interest of health & safety of employees.



Barrier: Stakeholder Management Plan

Barrier Category	System
Barrier Type	Administrative
Effectiveness	+ Good
Accountable	Corporate
Criticality	REQ Required Control

Description:

Working relationship amongst the tripartite parties including investors and communities, in the interest of health & safety of employees.

Hazard Sign Off

Sign off information for Hazard Dust- Respirable Crystalline Silica) / Liberation of Dust - Crystalline Silica

Build complete	No
Build Phase	
Sign off date	
Sign off comment	

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Activities

Dust Control Activities

Code	Details	Category	Frequency	Responsible	Barriers
Rev07	Training of Employees Employees to be trained on the appropriate use of HPD's	Training	Yearly	Operations	Wet Drilling Waterblast In-Stope Atomization for Dust Suppression Watering Down Multi-Stage Filtration System Tip Filtration System
Rev01	Review Hygiene reports Confirmation of measurements conducted within the workplace assessing the effectiveness of the control measures implemented	Inspection	Continuous	Operations	Fogging Dust Suppression System
Rev03	Environmental Monitoring (CRTM)	Inspection	Continuous	Engineering Department	Multi-Stage Filtration System
Rev04	Occupational Hygiene Monitoring Programme				In-Stope Atomization for Dust Suppression
Rev10	Maintenance	Maintenance	Monthly	Engineering Department	Wet Drilling Multi-Stage Filtration System Enclosed Cabins
Rev11	Pre work inspection	Inspection	Daily	Miner	Wet Drilling Waterblast In-Stope Atomization for Dust Suppression Multi-Stage Filtration System
Rev12	Design & Selection	Planning	As required	Operations Manager	Waterblast In-Stope Atomization for Dust Suppression Multi-Stage Filtration System Enclosed Cabins