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SOUTH AFRICA

MOSH Industry Dust Bowtie Analysis

Gold – Crystalline Silica (Underground)

Hazard: Respirable Crystalline Silica Dust

Hazard name:	Respirable Crystalline Silica Dust
Top event:	Liberation of Dust - Crystalline Silica
Affects:	Health
Description:	Dust containing respirable crystalline silica content, generated by various mining activities.

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List of Threats and Consequences

Threats	Threat Category
Cement Mixing - (Construction& Maintenance Works, shotcrete etc.)	MC Medium contribution
Falls of Ground & Barring	LC Low contribution
Drilling (Underground)	MC Medium contribution
Rockbreaking - Blasting	HC High Contribution
Sweepings & Vampings	HC High Contribution
Scraping	HC High Contribution
Ore Loading & Tipping	HC High Contribution
Tramming	HC High Contribution
Rockbreaking (Hydraulic Impact Breakers/Pickers)	MC Medium contribution
Tipping (Main tips)	MC Medium contribution
Ore Hoisting	MC Medium contribution
Ore Conveyance (Conveyor Belts)	MC Medium contribution
Backfilling	MC Medium contribution
Opening of Old Workings	MC Medium contribution

Consequences	Consequence Category
Dust Inhalation - Acute Exposure	MED Medium concern
Dust Inhalation - Chronic Exposure	MAJ Major concern
Business Continuity Disruptions	MAJ Major concern
Stakeholder Relations	MAJ Major concern

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List of Threats and Controls with descriptions

Threats	Controls
Cement Mixing - (Construction& Maintenance Works, shotcrete etc.) Any construction done for preparation or maintenance of mining work, this includes the application of cementitious coating of the sidewall and hanging wall, to prevent loose rock from falling or scaling.	**Remote Premixed Cement (Cementation Process)** Cement mixed remotely and pumped to underground workings.
	Wet-Creting Investigate applicability.
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.	**Watering Down** An act of applying water to suppress dust before undertaking dust causing activities.
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.	**Surface Wetting (Dry Drilling-Concrete)** Act of wetting of concrete surfaces before drilling.
	Wet Drilling Drilling of support or shot holes using steel drill rods with water outlets at drilling points.
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.	**Waterblast** Water sprays installed near blasting face and triggered by concussion to release water droplets for dust suppression.
	Reef Boring 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.

Threats	Controls
Rock breaking – Blasting (Continued)	**Oscillated Disc Cutting** 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.
Sweepings & Vampings Removal of all remaining broken ore left behind after scraping activity. This may commence during the stoping phase and continues to after stoping has been completed. High-powered vacuum machines or manually using shovels and/or steel brushes to sweep ore left behind.	**In-Stope Atomization for Dust Suppression** 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.
	Fogging Dust Suppression System 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.
	Water-Jetting Use of water at high pressure (jetting) to move fine broken rock material or ore from the stoping panels into the gullies.
	High Vacuum Machine Use of high-pressure vacuum machines to extract fine broken or ore particles.
	Watering Down An act of applying water to suppress dust before undertaking dust causing activities.

Threats	Controls
Scraping An ore conveyance process which includes movement of blasted rock from mining areas. using a winch.	**In-Stope Atomization for Dust Suppression** 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.
	Watering Down An act of applying water to suppress dust before undertaking dust causing activities.
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.	**Watering Down** An act of applying water using a hose to suppress dust before undertaking dust causing activities.
Tramming A process that involves loading, transporting, and dumping of materials in mines. Tramming equipment may include locomotives (trains) running on rails, haulage vehicles such as trucks and LHD vehicles (also known as scoop trams) explosive handling equipment.	**Fogging Dust Suppression System** 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.
	Footwall/Sidewall Treatment 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.
	Watering Down An act of applying water to suppress dust before undertaking dust causing activities.

Threats	Controls
Tramming (Continued)	**Rolling Stock Washing Bays** The Act of washing of rolling stock to remove ore spillage & slurry ore material that may dry overtime thus becoming airborne.
Rock breaking (Hydraulic Impact Breakers/Pickers) Breaking of big rocks at tips to allow their access into the tip for loading purposes.	**Fogging Dust Suppression System (Manual/Automated)** 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.
	Dust Filtration System Air exhausting system to extract contaminated air through a filter.
	Watering Down An act of applying water using a hose to suppress dust before undertaking dust causing activities.
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.	**Multi-Stage Filtration System** Primary dust engineering control at intake airways, which ensures that contaminated air is extracted through various stages of an air filtration unit**.**
	Fogging Dust Suppression System 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.
	Tip Filtration System An engineering control installation at the tip to filter contaminated air through filters.
	Tip Water Sprays Water sprays installed at the tip manually or automatically operated to released water for dust suppression.

Threats	Controls
Tipping - Main tips (Continued)	**Exhaust-Water Scrubber** The use of air extraction system where dust particles are trapped using a water base.
	Tip Covers Installation of cover doors (rubber or stee) at main tips to prevent the upcast of dust contaminated air as tipping occurs, especially in an interconnected ore transfer system.
Ore Hoisting Conveyance of broken ore from main shaft loading box, through the main shaft (man & material Shaft) to the surface silo belts.	**Ore Wetting Sprays** Water sprays installed at the loading box to ensure the ore is kept wet during conveyance to surface, thus liberating minimal dust levels.
	Shaft Mist Sprayers Water spraying system installed around the shaft barrel (Intake Airway) to release a water mist for dust suppression of dust because of ore conveyance, but also any dust from surface workings.
Ore Conveyance (Conveyor Belts) The movement of ore from tips to shaft bunkers through use of conveyor belts.	**Fogging Dust Suppression System** 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.
	Conveyor Belt Water Sprayers Water spray system where nozzles are installed along the belt at selected intervals to keep the ore moist but also to prevent airborne particle to travel further.
	LEV Filtration System (Tipping pts) An exhaust ventilation system installed at tipping points on the conveyor to extract contaminated air, through a filter.

Threats	Controls
Backfilling Cementous filling of in stope back areas for support and ventilation purposes. • Backfill bags for support (Disintegration). • Flushing of equipment • Spillages (Drying up). • Long hole stopes (Re-mining thru backfill)	**Waterdown** 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.
	Good housekeeping (Wash into drains) An act of cleaning backfill spillage on the footwall and equipment into the drains.
	Footwall treatment System (Nozzle + surfactant) 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).
Opening of Old Workings Opening of old workplaces because of re-mining or reclamation may result in dust liberation due to travelling and transportation of materials (agitation of settled dust).	**Watering Down** An act of applying water to suppress dust before undertaking dust causing activities.
	Fogging Dust Suppression System 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.

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List of Consequences and Controls with descriptions

Consequences	Controls
Dust Inhalation - Acute Exposure Dust inhalation which may result in short-term respiratory symptoms such as sneezing, coughing, lung-tissue swelling, asthma and throat infections	**Real Time Dust Monitoring** Monitoring of dust or airborne particulate matter engineering control performance and trigger action, automation, or alert.
	Respiratory PPE Dust respiratory personal protection equipment with the correct protection index
	Ventilation Control System Installation of ventilation control appliances to dilute/remove dust using ventilating air.eg. Fans, vent brattices, etc.
	Re-Entry Period An administrative control to regulate entry into workplace(s) after blasting.
	Centralized / Out-of-Sequence Blasting An administrative control to regulate blasting sequence to minimize exposure of employees to dust and other airborne contaminants because of blasting.
	Enclosed Cabins Mobile equipment operator enclosed cabins to serve as a barrier to dust exposure, whilst providing a comfortable and healthy working environment.
	Remote Loading (Tele-Remote) 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.

Consequences	Controls
Dust Inhalation - Chronic Exposure Dust inhalation which may results in long-term adverse respiratory diseases (occupational lung diseases such as Silicosis).	**Exhausting air directly to RAW** The control of ventilation air to flow directly into RAW, to prevent exposure of employees from the contaminated air.
	Water Spray Curtain (Fogger System) Water barrier through use of sprays to trap dust particles emanating from dust causing activity such as loading.
	Job Re-Classification The transfer of employees from high-risk areas (with regards to their exposure to dust) to low-risk areas in an aim to prevent an occupational lung disease which may have already started showing signs.
	Personal Dust Monitoring A formal system of Occupational Hygiene Measurements where employees are sampled for dust based on their HEG (Homogeneous Exposure Group) allocation and classification.
	Respiratory PPE Dust respiratory personal protection equipment with the correct protection index
	Ventilation Control System Installation of ventilation control appliances to dilute/remove dust using ventilating air.eg. Fans, vent brattices, etc.
	Re-Entry Period An administrative control to regulate entry into workplace(s) after the blast
	Centralized / Out-of-Sequence Blasting An administrative control to regulate blasting sequence to minimize exposure of employees to dust and other airborne contaminants because of blasting.

Consequences	Controls
Dust Inhalation - Chronic Exposure (Continued)	**Enclosed Cabins** Mobile equipment operator enclosed cabins to serve as a barrier to dust exposure, whilst providing a comfortable and healthy working environment.
	Remote Loading (Tele-Remote) 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.
	Scraper Winch Covers 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 scaping operations.
Business Continuity Disruptions Total or partial mine operation closure or production stoppage due to statutory instructions because of non-compliance.	**Business Continuity Management Plan** Total or partial mine operation closure or production stoppage due to statutory instructions because of non-compliance.
Stakeholder Relations Working relationship amongst the tripartite parties including investors and communities, in the interest of health & safety of employees.	**Stakeholder Management Plan** Working relationship amongst the tripartite parties including investors and communities, in the interest of health & safety of employees.