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Adaptation of Engineering Hierarchy of Control for Dust Management

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Why?

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Example Dust Sources/Controls

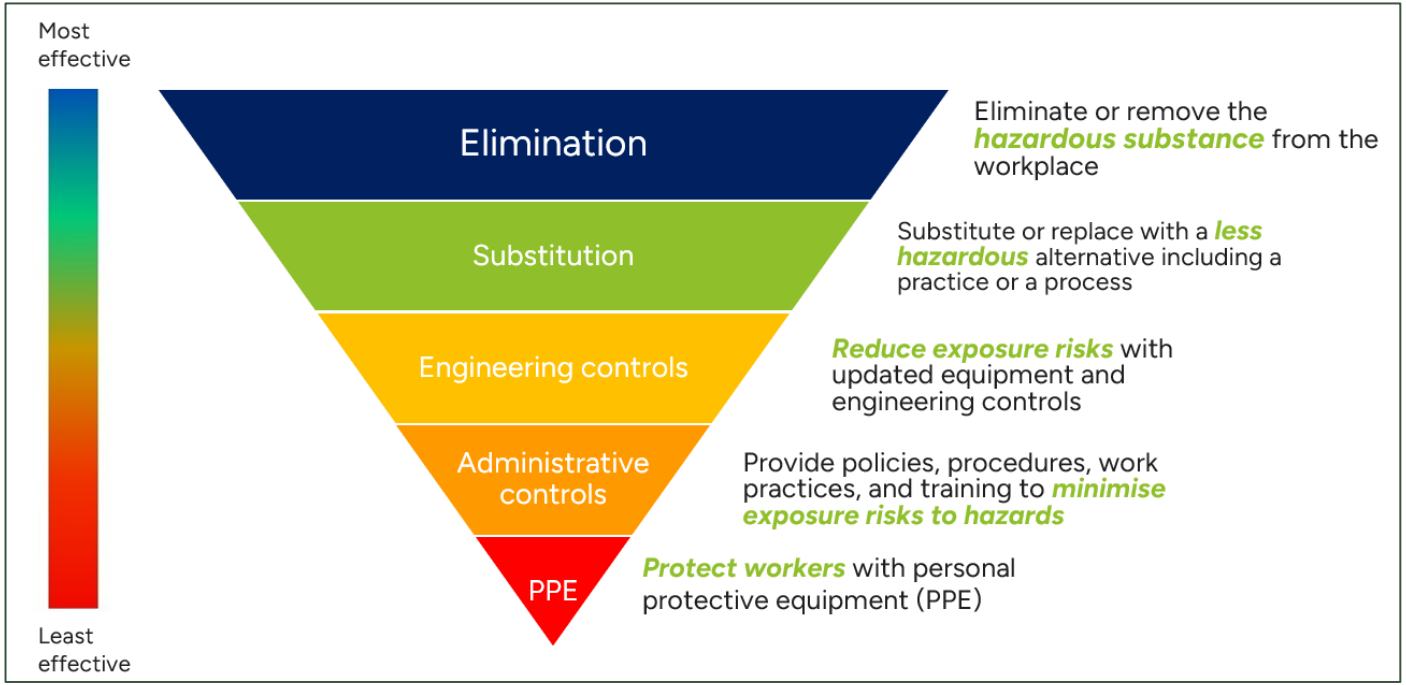
Dust Source	Dust Control Measure Type					
	Design Optimisation	Containment / Enclosure	Dust Suppression (Water/Fog)	Dust Extraction	Wind Management	Operational Controls
Truck / Rail Unloading Hopper	✅	✅	✅	✅	✅	✅
Conveyor Transfer Points	✅	✅	✅	✅	❌	✅
Stacker Operations	✅	❌	✅	❌	✅	✅
Stockpile Wind Erosion	❌	❌	✅	❌	✅	✅
Reclaimer Operations	✅	❌	✅	❌	✅	✅
Conveyor Routes	✅	✅	❌	❌	❌	✅
Ship Loader Discharge	✅	✅	✅	✅	❌	✅
Loading into Vessel Holds	✅	✅	✅	✅	❌	✅
Vehicle Movements / Haul Roads	❌	❌	✅	❌	❌	✅

✅ Primary or commonly applied control measure
❌ Generally not applicable or not commonly used

What?

Hierarchy of Control (HOC)

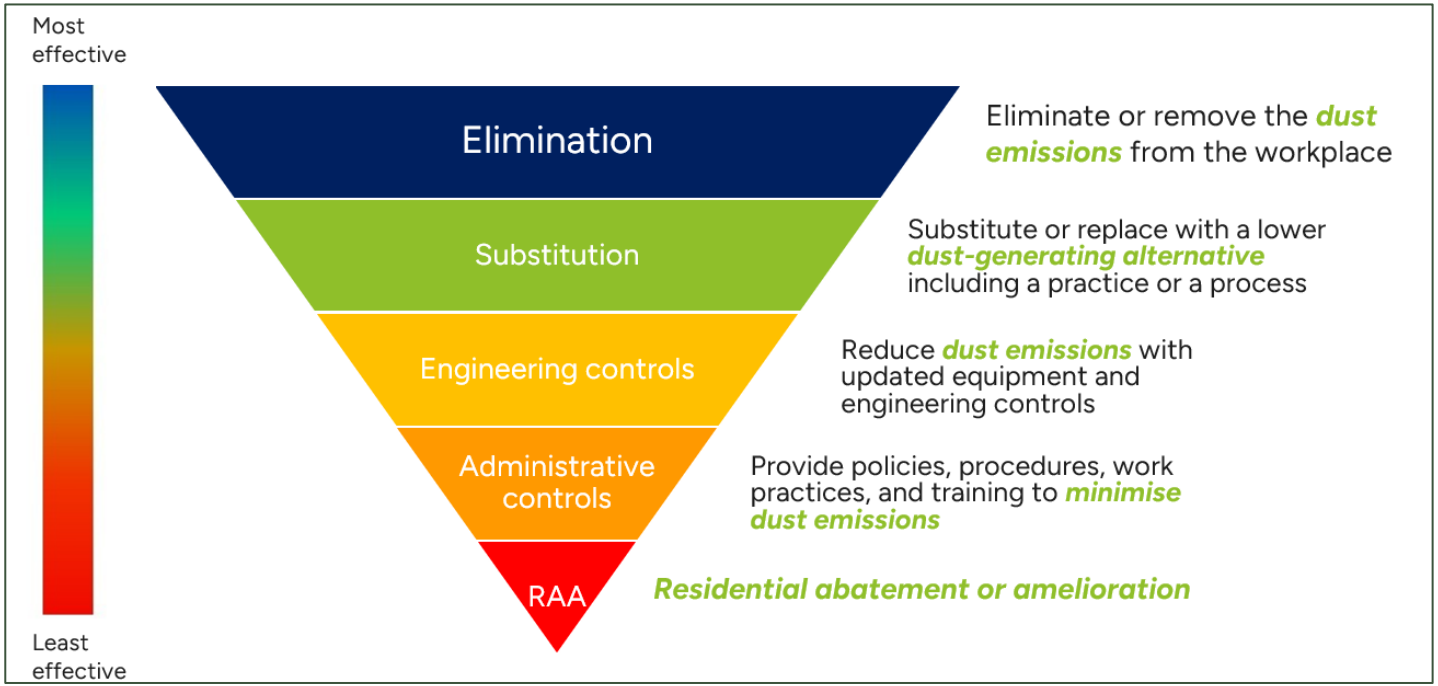
- Well-established method for lowering workers' exposure to *hazardous substances*
- Developed to manage *risks and hazards*



Dust control handbook for industrial minerals mining and processing. Second edition NIOSH, 2019

Hierarchy of Dust Controls (HODC)

- Identify *dust emission controls* for a specific site/source
- Use structure of HODC to rank *dust emission reduction* potential of each control
- Provide structured guidance



How?

Elimination

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Elimination

Image generated using Microsoft Copilot (2026)

Substitution

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Engineering Controls

SOURCE CONTROL

- Install or upgrade equipment to control dust at the source.

DUST TREATMENT

- Apply extraction, filtration, or suppression systems.

SYSTEM MAINTENANCE

- Maintain and inspect controls regularly.

Sub-categories: Containment | Capture Collection | Suppression | Process Monitoring

Engineering Controls: Containment

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Engineering Controls: Capture/Collection

1. PROPER DUST CAPTURE

- Maintain negative pressure in extraction zone
- Design capture points for specific material
- Control and interlock systems

2. EFFICIENT DUST COLLECTION

- High-efficiency baghouse and cartridge filters are preferred
- Custom design to match materials and process
- Automatic monitoring of pressure

3. PM_{10} EFFICIENT ROAD SWEEPERS

- Use PM_{10} efficient sweepers on sealed roads
- Capture fine dust to reduce airborne pollution
- Routine and effective cleaning

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Engineering Controls: Suppression

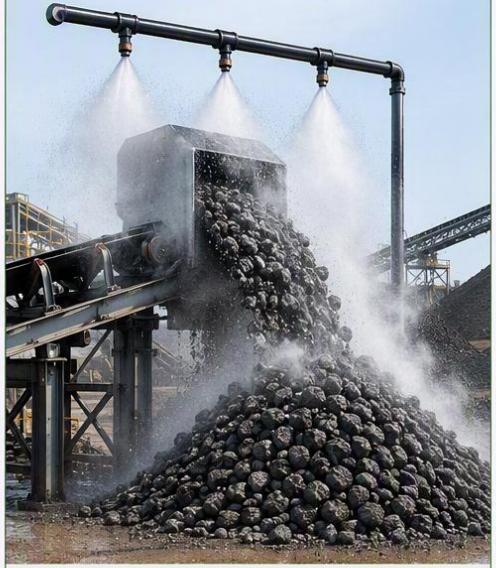
1. WATER SPRAY SUPPRESSION

Conventional water sprays

Coarse water droplets are sprayed onto material at transfer points, loading points and other emission sources to add moisture, increase particle weight and reduce dust generation.

2. DRY FOG SUPPRESSION

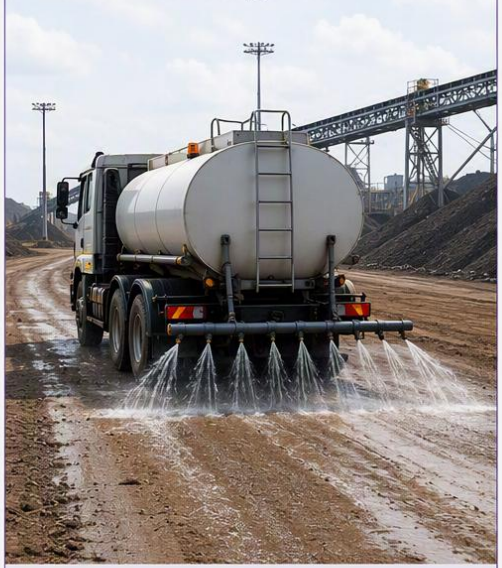
High-pressure dry fog systems



Ultra-fine water droplets (10–50 microns) are generated at high pressure. The droplets capture and agglomerate airborne dust particles, causing them to settle and reducing dust emissions.

3. CHEMICAL SUPPRESSANTS

Surface application



Liquid chemical suppressants are applied to roads, stockpiles or work areas. The product binds particles together and forms a crust or film that resists dust entrainment.

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Engineering Controls: Process Monitoring

1. MOISTURE MONITORING SYSTEMS

Real-time measurement of material moisture content enables proactive control of water sprays or suppressants to maintain optimal moisture levels and minimise dust generation.

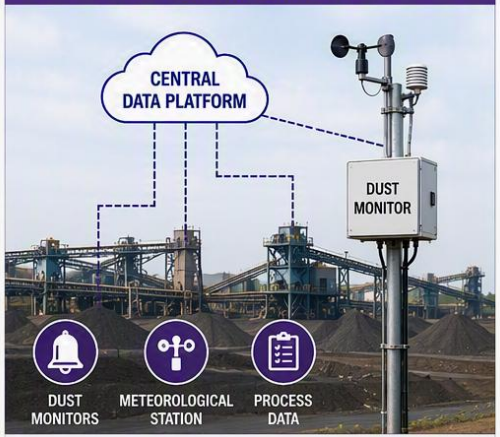
- Online moisture sensors on conveyors, at transfer points and stockpiles
- Continuous data for automated moisture control
- Alarms for out-of-range conditions and system malfunctions

2. CONTROL EQUIPMENT FUNCTIONALITY MONITORING

Monitoring of dust control equipment ensures all components are operating as intended and provides early warning of faults or performance issues.

- Pump pressure and flow monitoring
- Nozzle function and blockage detection
- Equipment status and connectivity monitoring
- Automated alerts and maintenance notifications

3. INTEGRATION WITH DUST MONITORING NETWORKS



Integration with dust and meteorological monitoring networks enables data-driven decision making, performance evaluation and regulatory reporting.

- Correlate dust levels with process and environmental data
- Centralised data platform and dashboards
- Reporting, compliance and continuous improvement

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Administrative Controls

Develop and enforce procedures and work practices to minimise dust emissions.

Provide training for workers on dust emissions and control measures.

Schedule high-dust tasks during favourable meteorological conditions (e.g, low wind speeds, winds blowing away from sensitive receptors)

Implement **housekeeping** practices such as regular cleaning using methods that do not re-suspend dust

Image generated using Microsoft Copilot (2026)

Residential Abatement or Amelioration (RAA)

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What Next?

Best Practice Summary – HODC Categories

Emission Source	HODC Level			Mitigation Measure	Control Effectiveness
Rail car unloading	Engineering	Containment	A1	Design for material properties	Not Quantified
			A2	Enclosure plus extraction system and interlock system	95-99.9%
		Suppression	A3	Dry Fog	90%
			A4	Water sprays	50%
		Best Practice		***A1+A2***	
Truck unloading	Engineering	Containment	B1	Truck unloading containment systems	90-100% per tonne
			B1a	Enclosure plus extraction system and interlock system	90-100% per tonne
		Suppression	B2	Dry Fog	90%
			B3	Water sprays	50%
		Best Practice		***B1 OR B1a***	
Conveyors/ transfer points/ chutes	Elimination		C1	Minimise number of transfer points	100% per transfer point avoided
	Engineering	Containment	C2	Design for material properties	Not Quantified
			C3	Minimise vertical fall distance	Not Quantified
			C4	Feed material to centre of belt	Not Quantified
			C5	Maintain good belt alignment	Not Quantified
			C6	Enclosure of transfer points	70%
			C7	Belt cleaning and spillage minimisation	94%
			C8	Conveyors - wind shielding - roof OR side wall	40%
			C9	Conveyors - wind shielding - roof AND side wall	70%
		Suppression	C10	Dry Fog	90%
			C11	Water sprays	50%
		Best Practice		***C1+C2+C6+C7+C9+C10***	
Screening	Elimination		D1	Relocate screening to mine.	100% per tonne relocated
	Engineering	Containment	D2	Enclosure of screens	70%
		Capture/ collection	D3	Enclosure including extraction system	95-99.9%
		Suppression	D4	Water sprays	Not Quantified
		Best Practice		***D1 or D3+D4***	
Stockpiles (wind erosion)	Elimination		E1	Full enclosure of stockpiles and associated material handling activities	100% per m^2 fully enclosed
			E2	Direct to ship loading	100% per tonne
			E3	Minimise surface area of stockpiles at Port	100% per m^2 avoided
	Substitution		E4	Locate dustier and/or more intensively handled ore grades away from receptors/out of the range of prevailing wind pathways to the nearest receptors	Site specific
	Engineering	Containment	E5	Wind fences (upwind and downwind)	75-80%
		Suppression	E6	Chemical wetting agents/veneers	80-99%
			E7	Water sprays	50%
		Best Practice		***E1***	
Stockpiles (stacking)	Elimination		F1	Maximise direct to ship loading	100% per tonne
			F2	Full enclosure of stockpiles and associated material handling activities	100% per m^2 fully enclosed
	Substitution		F3	Locate dustier and/or more intensively handled ore grades away from receptors/out of the range of prevailing wind pathways to the nearest receptors	Site specific
	Engineering	Containment	F4	Telescopic chute to minimise drop height, with water sprays	75%
		Suppression	F5	Dry fog/fog blanket	90%
			F6	Boom tip water sprays	50%
		Best Practice		***F2***	

Emission Source	HODC Level			Mitigation Measure	Control Effectiveness
Stockpiles (reclaiming)	Elimination		G1	Maximise Direct to Ship Loading	100% per tonne
			G2	Full enclosure of stockpiles and associated material handling activities	100% per m^2 fully enclosed
	Substitution		G3	Locate less dusty and less intensively handled ore grades closest to receptors/within the range of prevailing wind pathways to the nearest receptors	Site specific
	Engineering	Suppression	G4	Dry fog/fog blanket	90%
			G5	Water sprays	50%
	Best Practice			***G2***	
Roads	Substitution		H1	Upgrading unsealed roads to sealed roads	Site specific
	Engineering	Capture/ Collection	H2	PM_{10}-efficient road sweeper on sealed roads	80%
		Suppression	H3	Chemical dust suppressants on unsealed roads	Site/product specific
			H4	Water application on unsealed roads	Site specific
	Best Practice			***H1+H2***	
Open Areas (wind erosion)	Engineering	Suppression	I1	Chemical suppressants/crusting agents	80-99%
			I2	Watering	50%
	Best Practice			***I1***	

Best Practice Summary – HODC Categories

Emission Source	HODC Level			Mitigation Measure	Control Effectiveness
Stockpiles (reclaiming)	Elimination		G1	Maximise Direct to Ship Loading	100% per tonne
			G2	Full enclosure of stockpiles and associated material handling activities	100% per m^2 fully enclosed
	Substitution		G3	Locate less dusty and less intensively handled ore grades closest to receptors/within the range of prevailing wind pathways to the nearest receptors	Site specific
	Engineering	Suppression	G4	Dry fog/fog blanket	90%
			G5	Water sprays	50%
	Best Practice			***G2***	
Roads	Substitution		H1	Upgrading unsealed roads to sealed roads	Site specific
	Engineering	Capture/ Collection	H2	PM_{10}-efficient road sweeper on sealed roads	80%
		Suppression	H3	Chemical dust suppressants on unsealed roads	Site/product specific
			H4	Water application on unsealed roads	Site specific
	Best Practice			***H1+H2***	
Open Areas (wind erosion)	Engineering	Suppression	I1	Chemical suppressants/crusting agents	80-99%
			I2	Watering	50%
	Best Practice			***I1***	

SELF ASSESSMENT TOOL

DUST CONTROL

Current Measures

- Local Exhaust Ventilation
- Water Suppression
- PPE & Housekeeping

COMPARE

Best Practices

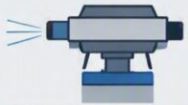
- Advanced Ventilation
- Dust Monitoring
- Engineering Controls

Guidance on Improvements

Enhanced PPE

Enclosures & Barriers

Automated Spray Systems



Additional Measures to Implement

Self Assessment Tool - Summary

Whole of facility controls	
Inside municipal area?	This facility has been relocated outside of the muncipal area. This exceeds best practice.
Does the facility have full enclosure with dust capture of all activity other than ship loading?	This facility has full enclosure of all activity except ship loading. This exceeds best practice.

Best Practice Measures (Whole of Facility)		Process Monitoring	Rail Car Unloading	Truck Unloa
This facility has the following Whole of Faclity controls:				
K5	Are in-line moisture sensors installed - Best practice is determined to be: Neutron activation sensors for magnetite and microwave sensors for other ores	None		
K6	Is material maintained above DEM throughout plant?	Some (<95%)		
K7	Is process monitoring available to confirm dust control system functionality at all times?	Some (<95%)		
K1	Are capture devices fitted where emissions have potential to escape containment systems?	Not relevant	Some	None
K2	Where relevant, is negative pressure maintained in the extraction area?		Some	None
K3	Where relevant, are interlocks and alarms installed to ensure system is online when required?		Some	None
K4	Does design of sprays and nozzles account for material properties/environmental conditions s they vary at each stage of the process?		Some	None
	Best Practice Determination: Whole of Facility	Does not meet best practice	Does Not Meet Best Practice	Does Not Meet Be

Self Assessment Tool - Summary

Administrative controls

his facility has the following Administrative controls:		
K8	Dust Management Plan(s) including performance criteria	No
K9	Trigger Action Response Plan	Yes
K10	Environmental Management System	Yes
K11	Real time dust monitoring program	No
K12	Staff training	Yes
K13	Good housekeeping	No
	Best Practice Determination: Administrative Controls	Dust monitoring activities are considered less than best practice

Dust Monitoring

ummary of facility Air Quality Monitoring Program:		
K11(a)	AQMP designed with appropriate objectives as (per Section 5.8.5.1), including all known hazards, eg PM_{10}/$PM_{2.5}$/metals/air toxics/other hazardous air pollutants, incorporating at source, downwind between source and receptor and at sensitive location monitoring	Yes
K11(b)	AQMP objectives are documented	Yes
K11(c)	AQMP employs quality control procedures and these are documented (ideally in the dust management plan)	Yes
K11(d)	AQMP incorporates real time monitoring via telemetry (or similar) allowing data checking and alerts	Yes
K11(e)	AQMP incorporates meteorological monitoring	Yes
K11(f)	AQMP incorporates LiDAR or equivalent source strength monitoring (NB: not considered in overall determination)	Yes
K11(g)	Sensitive receiver monitoring stations include AS/NZS compliant monitoring systems	Yes
K11(h)	Data are routinely reviewed to: - identify trends - confirm appropriate data capture rates - verify optimised siting of monitoring stations - confirm expected improvements from dust control implementation are realised - confirm that elevated readings are appropriately responded to and investigated - confirm that TARP trigger levels are appropriate for effective dust management	Yes
	Best Practice Determination: Dust Monitoring	Dust monitoring activities exceed best practice

Do you have any questions?

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