Preventing Dust from Entering Mobile & Fixed Plant Cabins

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The Message

1. Cabin integrity critical factor in protecting operators from exposure to respirable dust
2. Filtration of incoming and recirculating air must effectively capture respirable-fraction dust
3. Cabin cleaning methods must be appropriate and not increase exposure risk
4. Falling Exposure Standards will mean that effective in-cabin protection is increasingly important

Dust Control Practice

STOP dust getting airborne - Treat at source

- Water sprays (prevention), extraction / collector systems, screen covers, shrouds

If dust gets airborne - Interrupt the pathway

- Water sprays (suppression) misting sprays to capture airborne dust
- Enclosed mobile plant / crushing plant cabins

If dust gets to the worker - Protect at worker

- Respiratory protection

Dust Self-assessment Report (2010)

~90% of mines and quarries rely on air-conditioned cabins to control dust exposure

POWERSCREEN

KOMATSU
PC
300
LC
KOMATSU
KOMATSU

Enclosed Cabins

Operators assume they are protected….but

- Incoming air filtration – capture efficiency?
- Recirculation filtration – capture efficiency?
- Secondary exposures from clothing, dust trapped in seat, drying material on floor.
- How is cabin cleaned?
  - Compressed air blow-out / dry sweeping / damp wipe / vacuum
  - How often are cabins cleaned?

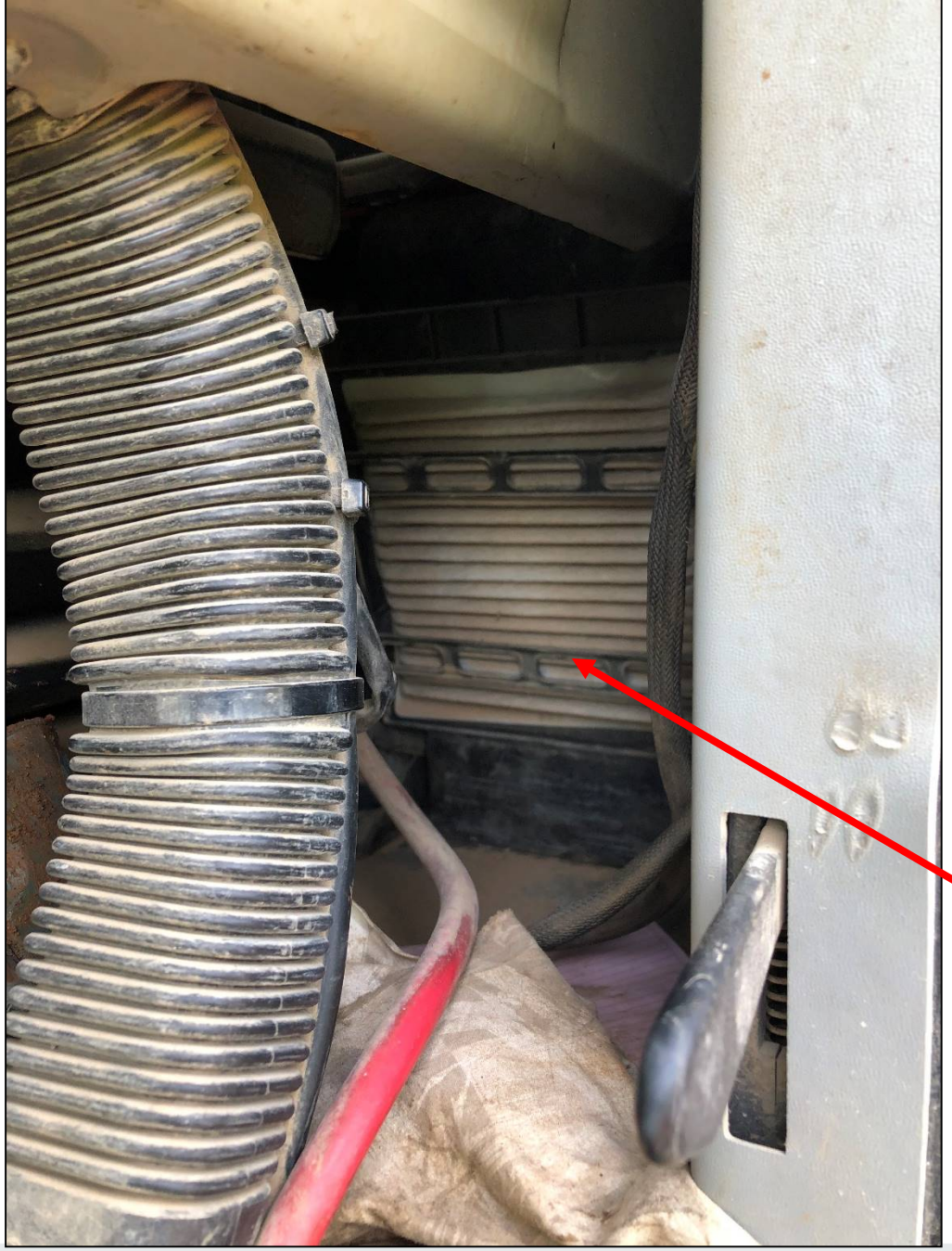
or in some cases…..just not cleaned at all.

Exposure Potential?

20% of workers self-report using compressed air to clean filters and cabins (Probably higher)

A further 36% self-report using dry-sweeping to clean dust from cabins

- 30% had no / inadequate training on RCS
- 35% had no / inadequate training on RPD



‘Lounge-chair’ foam filtration

Difficult to access, inspect and clean

Deformed and damaged recirculation filter

Filter overloading

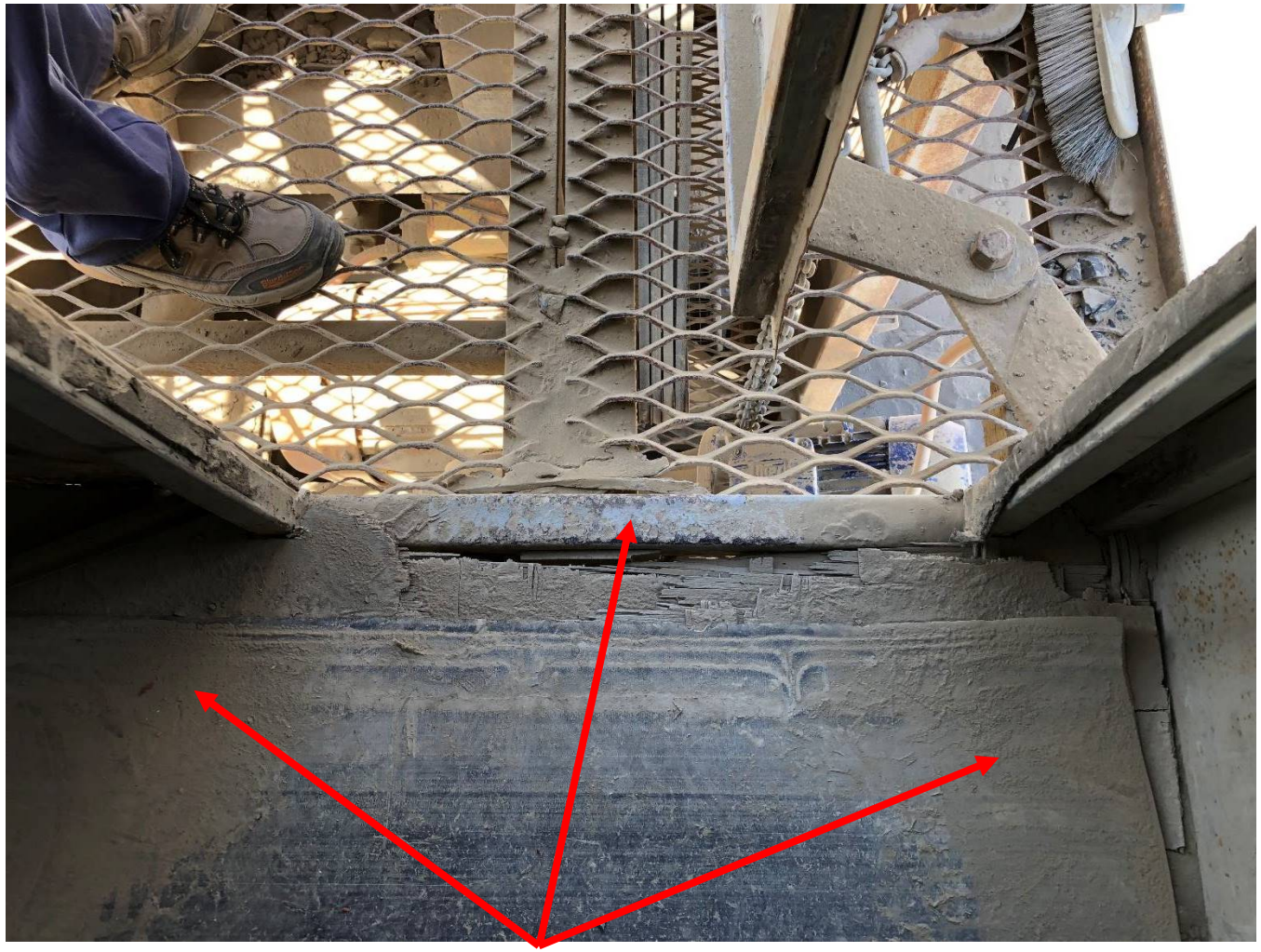
Filters difficult to access, inspect or clean.

Filter not set properly in mounting-frame.

Large gaps.

Doors not self-closing

Damaged door seals



Damaged door seals & clearly visible dust

No door seals

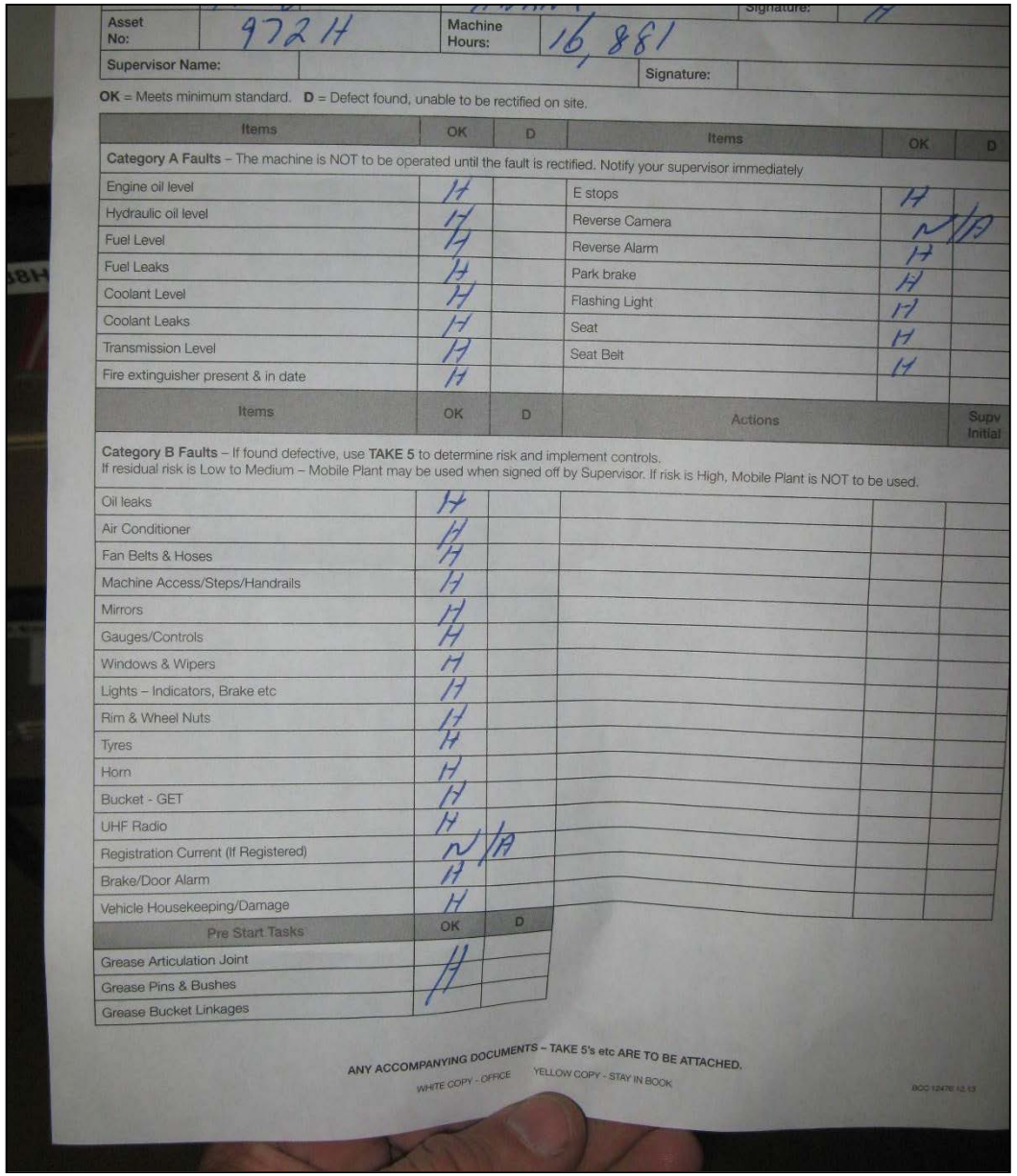
C.C.R. A/c – Filter in place

C.C.R. A/c – Filter removed

Large mud-wasp nest

Exposure Potential?

- Almost NO Mobile Plant pre-start checklists look at either door seals or condition of A/c filtration,
- Air conditioning filters often only checked at 250-hour service
- Air-conditioning check is just making sure it works



Asset No:	972H	Machine Hours:	16,881
Supervisor Name:		Signature:	

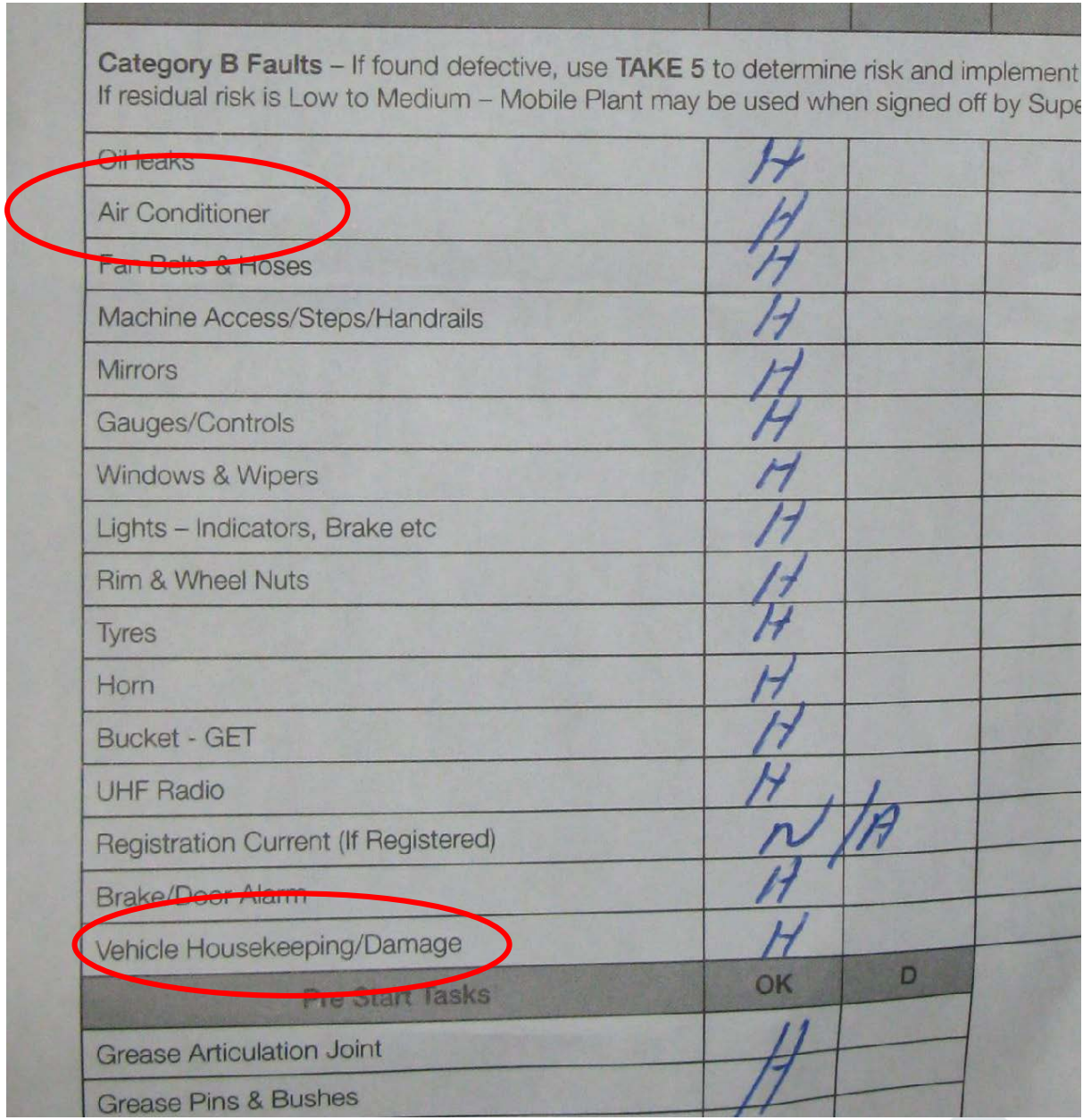
OK = Meets minimum standard. **D** = Defect found, unable to be rectified on site.

Items	OK	D	Items	OK	D
Category A Faults – The machine is NOT to be operated until the fault is rectified. Notify your supervisor immediately					
Engine oil level	H		E stops	H	
Hydraulic oil level	H		Reverse Camera	N/A	
Fuel Level	H		Reverse Alarm	H	
Fuel Leaks	H		Park brake	H	
Coolant Level	H		Flashing Light	H	
Coolant Leaks	H		Seat	H	
Transmission Level	H		Seat Belt	H	
Fire extinguisher present & in date	H				

Items	OK	D	Actions	Supv Initial
Category B Faults – If found defective, use **TAKE 5** to determine risk and implement controls. If residual risk is Low to Medium – Mobile Plant may be used when signed off by Supervisor. If risk is High, Mobile Plant is NOT to be used.				
Oil leaks	H			
Air Conditioner	H			
Fan Belts & Hoses	H			
Machine Access/Steps/Handrails	H			
Mirrors	H			
Gauges/Controls	H			
Windows & Wipers	H			
Lights – Indicators, Brake etc	H			
Rim & Wheel Nuts	H			
Tyres	H			
Horn	H			
Bucket - GET	H			
UHF Radio	H			
Registration Current (If Registered)	N/A			
Brake/Door Alarm	H			
Vehicle Housekeeping/Damage	H			
Pre Start Tasks	**OK**	**D**		
Grease Articulation Joint	H			
Grease Pins & Bushes	H			
Grease Bucket Linkages				

ANY ACCOMPANYING DOCUMENTS – TAKE 5's etc ARE TO BE ATTACHED.

WHITE COPY - OFFICE YELLOW COPY - STAY IN BOOK



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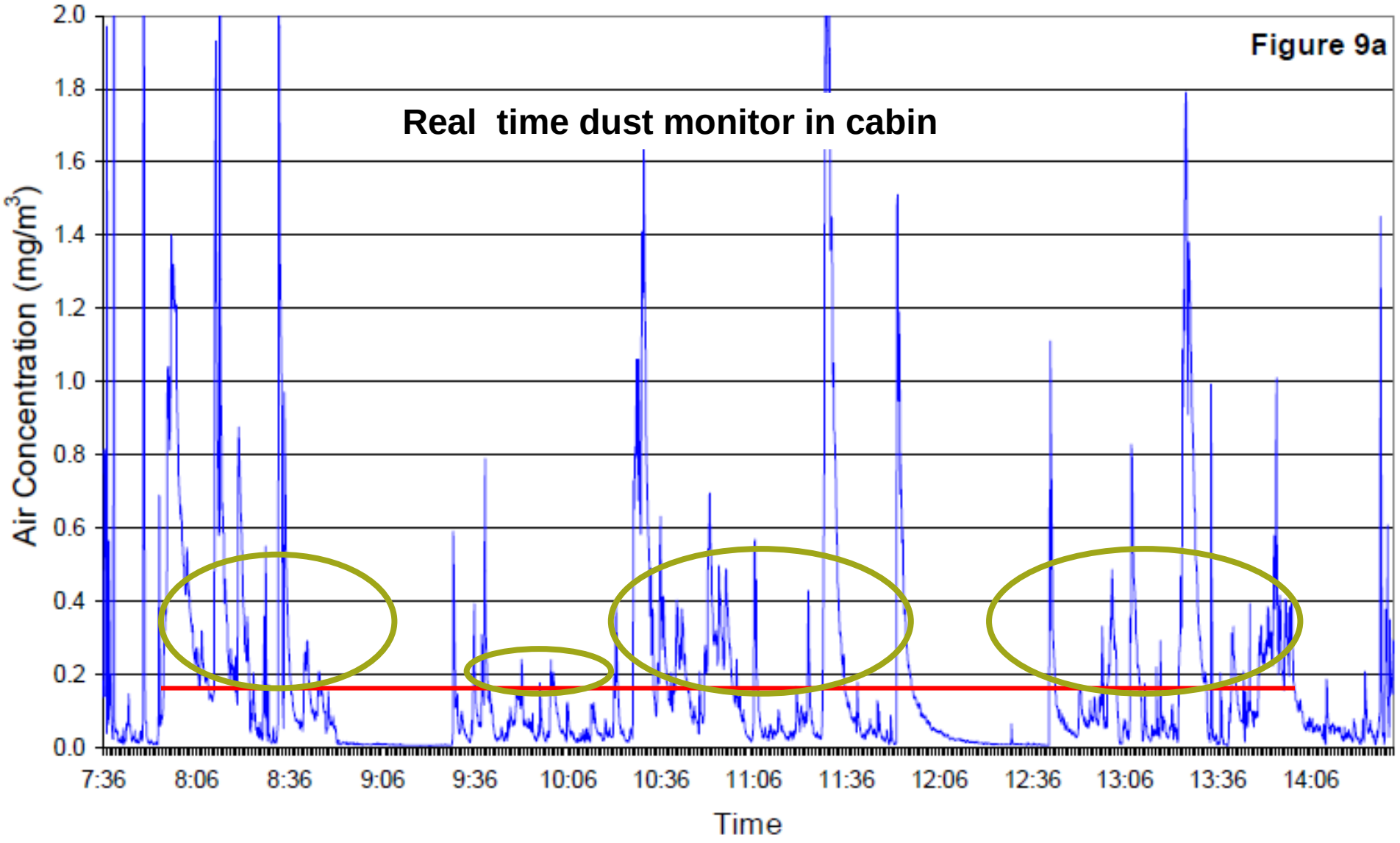
Pre Start Tasks	**OK**	**D**	
Grease Articulation Joint	H		
Grease Pins & Bushes			

Exposure Potential?

Examples of static monitoring:

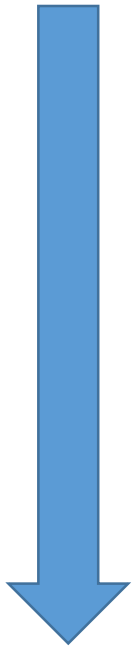
1. C.C.B. statics for RD and RCS both > than Operator's personal results
2. C.C.R. static RCS >50% of C.R.O. personal result,
3. Excavator cabin static RD > Operator's personal and static RCS 2/3 of personal RCS,
4. Loader cabin static RD > Operator's personal result

RESPA Trial ~2010



Cabin Cleaning

WORST



BEST

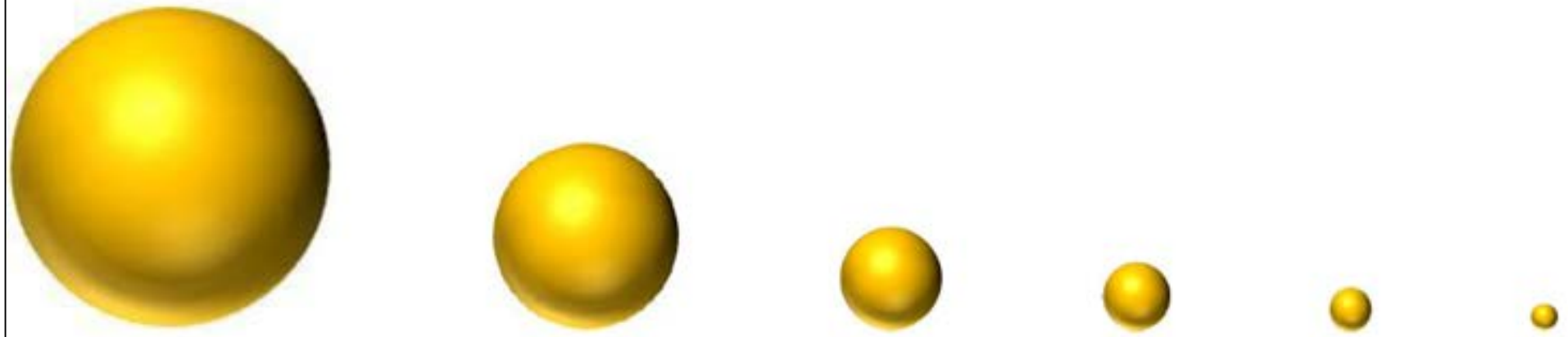
- Compressed air blow-out
- Rapid dry sweeping
- Non-HEPA vacuum
- Careful dry-sweeping
- Damp wiping
- Vacuum
- or a combination? With PPE?

RISK ASSESSMENT

Dust - Settling Time

Typical settling rates for different sized mist droplets
...from a height of 1.5m in still air

20µm	10µm	5µm	2µm	1µm	0.5µm
3.6 mins	8.3 mins	35.7 mins	2.8 hrs	12 hrs	41.7 hrs



The airborne hazard will often continue to be present long after work has stopped...

Dust and Particulates

Total Dust:

- Inhalable Fraction — D_{50} = 100 um
- Thoracic Fraction — D_{50} = 11.6 um
- Respirable Fraction — D_{50} = 4.25 um

Exposure Limits

Respirable dust	5.0 mg/m³ (PNOS / Qld MMQ)	
	3.0 mg/m³ (ACGIH)	
	2.5 mg/m³ (Qld Coal)	→ 1.5 mg/m³
RCS	0.1 mg/m³	→ 0.05 mg/m³

Vacuum Cleaner Filters

- AS/NZS 60335.2.69 – Household and similar electrical appliances – Safety (Commercial wet / dry vacuum cleaners)

6.AA.201 The machines are classified according to dust classes:

– L (light hazard) suitable for separating dust with a limit value of occupational exposure of greater than 1 mg/m^3;

– M (medium hazard) for separating dust with a limit value of occupational exposure not less than 0,1 mg/m^3;

– H (high hazard) for separating all dusts with all limit values of occupational exposure, including carcinogenic and pathogenic dusts.

NOTE 1 The use of an **essential filter** of a specified dust class does not allow the complete machine to be classified with that dust class.

NOTE 2 In some countries, national regulations exist concerning disposal of **hazardous dusts**.

Cleaning Cabins - Vacuums

Dust class	Suitability for hazardous dust with limit values for occupational exposure mg × m^{-3}	Degree of penetration *D* %
L (light hazard)	> 1	< 1
M (medium hazard)	≥ 0,1	< 0,1
H (high hazard)	< 0,1 , including carcinogenic dusts and dusts contaminated with carcinogens and/or pathogens	< 0,005

AS/NZS 60335.2.69

Table AA.1

(Penetration Limits

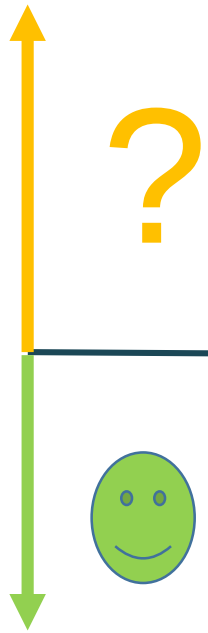
= 99% capture

= 99.9% capture

= **99.995% capture**

Air Conditioning Filtration

- AS 4260-1997_R2018 – HEPA Filters



2.2 PERFORMANCE GRADES The performance grades of filters shall be one of the following:

(a) *Grade 1*—a filter that has been tested for efficiency at the rated airflow and found to be equivalent to not less than 99.97% filtration efficiency for nominal 0.3 µm diameter particles.

(b) *Grade 2*—a filter that has been—

(i) tested for efficiency at the rated airflow and found to be equivalent to not less than 99.99% filtration efficiency for nominal 0.3 µm diameter particles; and

(ii) leak tested in accordance with AS 1807.6.

(c) *Grade 3*—a filter that has been—

(i) tested for efficiency at the rated airflow and found to be equivalent to not less than 99.999% filtration efficiency of nominal 0.3 µm diameter particles; and

(ii) leak tested in accordance with AS 1807.6.

(d) *Grade 4*—a filter that has been tested for efficiency at the rated airflow and found to have not less than 99.999% filtration efficiency for 0.12 µm diameter particles.

HEPA Specs (EN1822)

EN1822 Sınıflandırması		EN1822 Classification				ISPE
Filter Group	Class	MPPS Integral Values		MPPS Local Values		Minimum Efficiency (%) @ DOP (0,3 µm)
		Efficiency (%)	Penetration (%)	Efficiency (%)	Penetration (%)	
EPA	E10	85	15	-	-	95
	E11	95	5	-	-	99,9
	E12	99,5	0,5	-	-	99,97
HEPA	H13	99,95	0,05	99,75	0,25	99,99
	H14	99,995	0,005	99,975	0,025	99,999
ULPA	U15	99,9995	0,0005	99,9975	0,0025	-
	U16	99,99995	0,00005	99,99975	0,00025	-
	U17	99,999995	0,000005	99,9999	0,0001	-

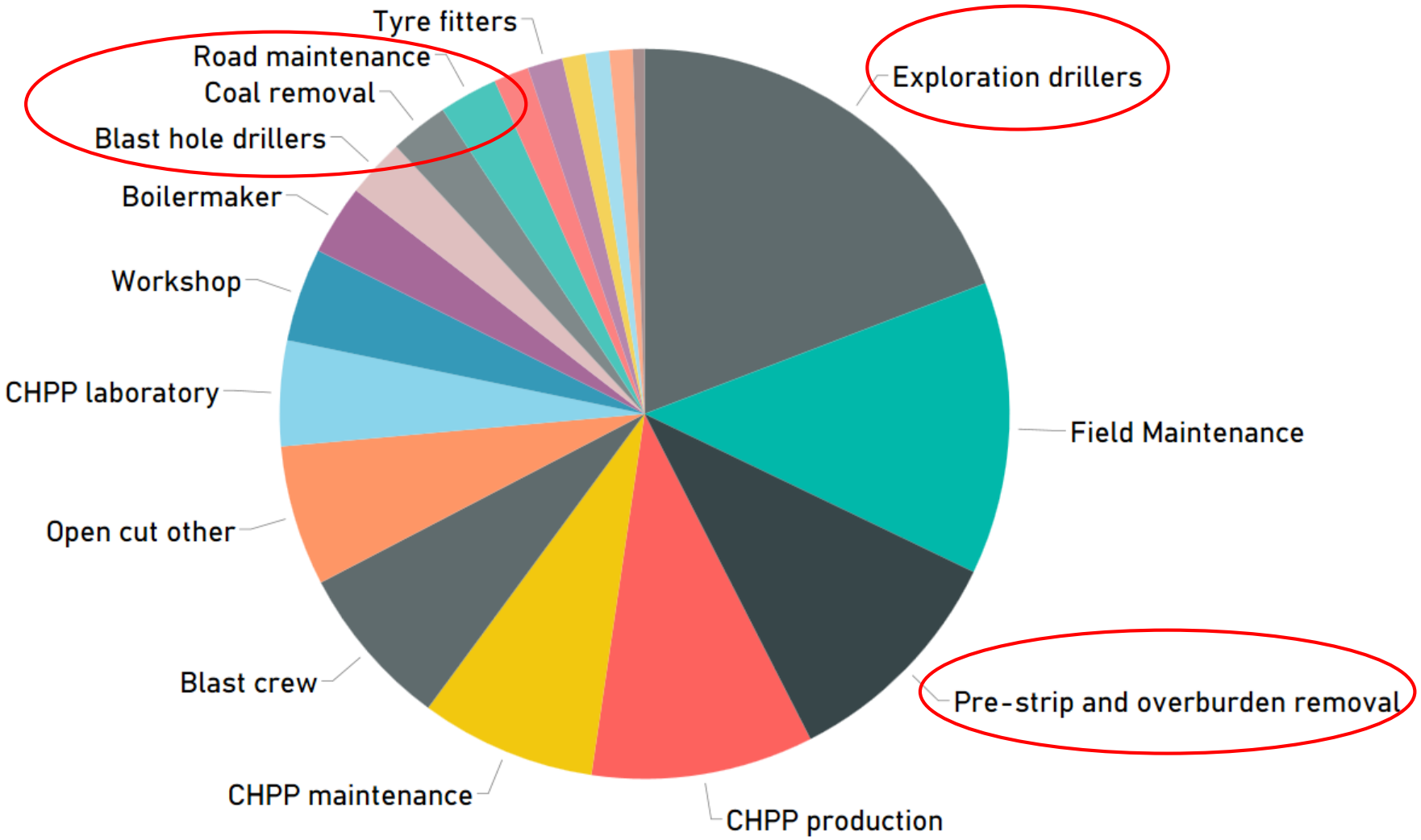
MPPS: Most Penetrating Particle Size (En çok nüfuz eden partikül boyutu)

Efficiency: Verimlilik, **Penetration:** Nüfuz Etme

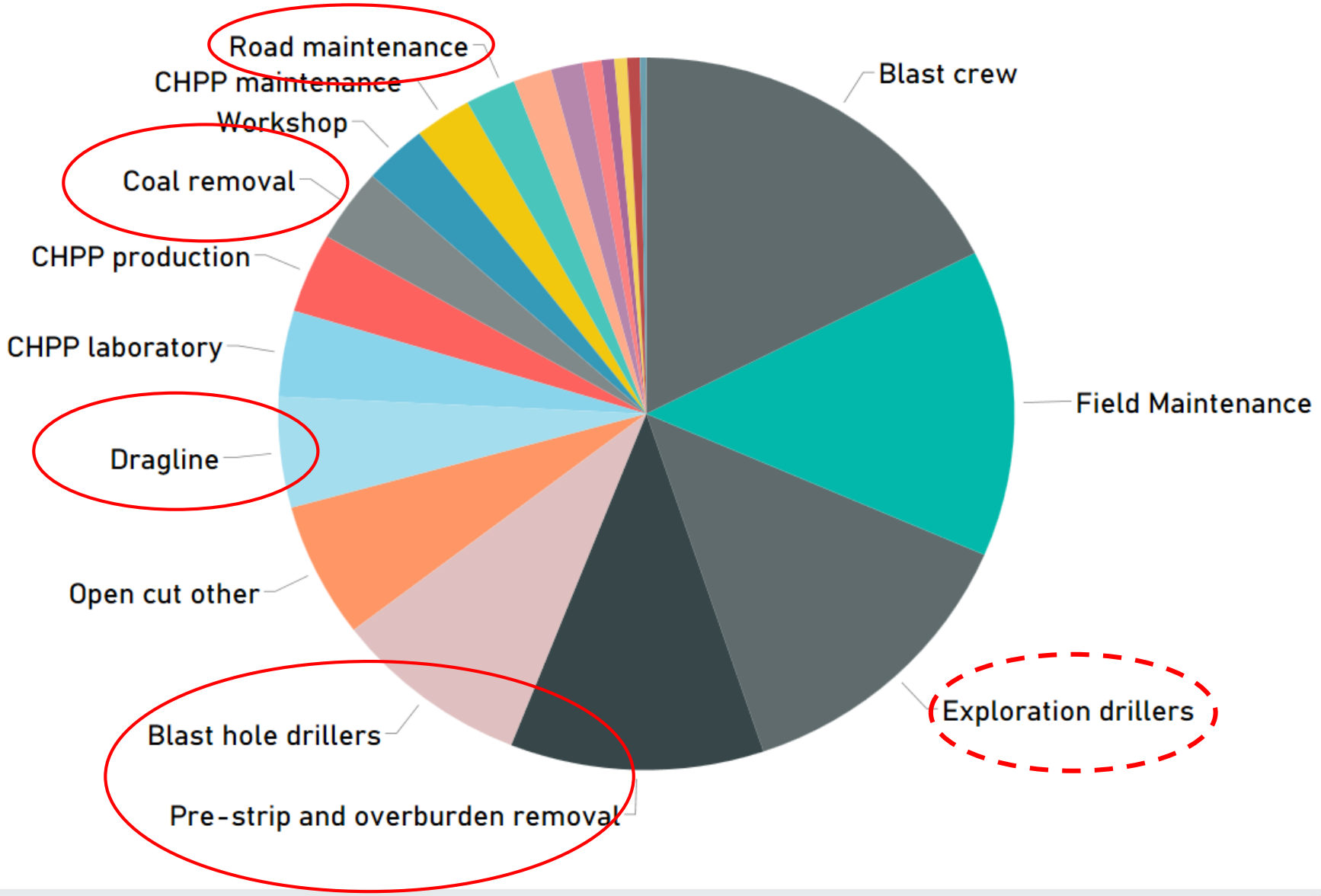
Example label – Class H Vacuum

O.I.R - Maintenance Inspection & Testing of H-class Vacuum Cleaners

Exceedance by SEG – Dust (RD)



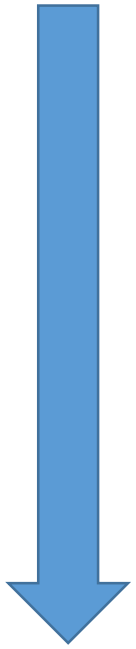
Exceedance by SEG – Silica (RCS)



Cabins

WORST

- No filtration / no inspection / no cleaning

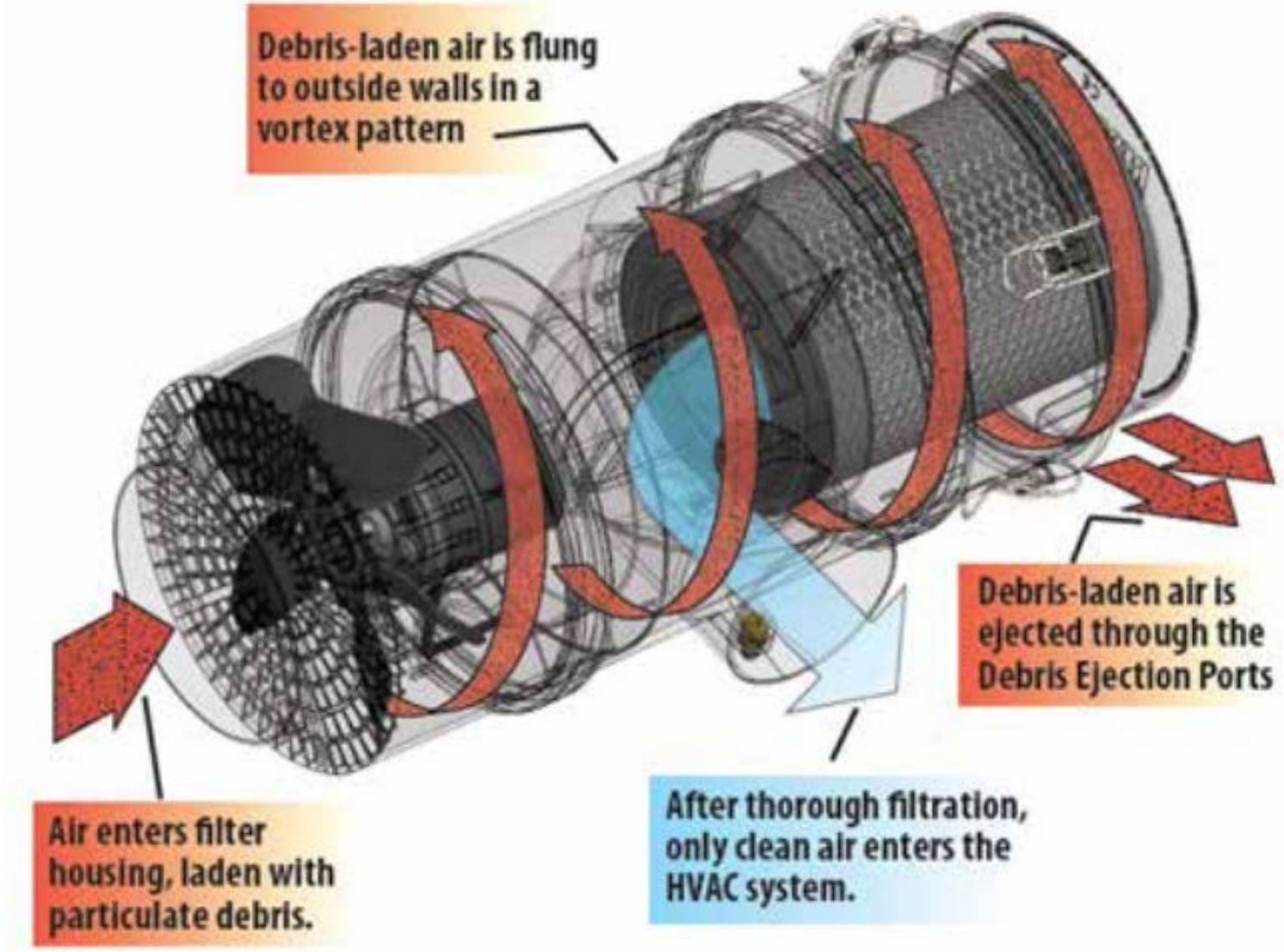


What's your process?

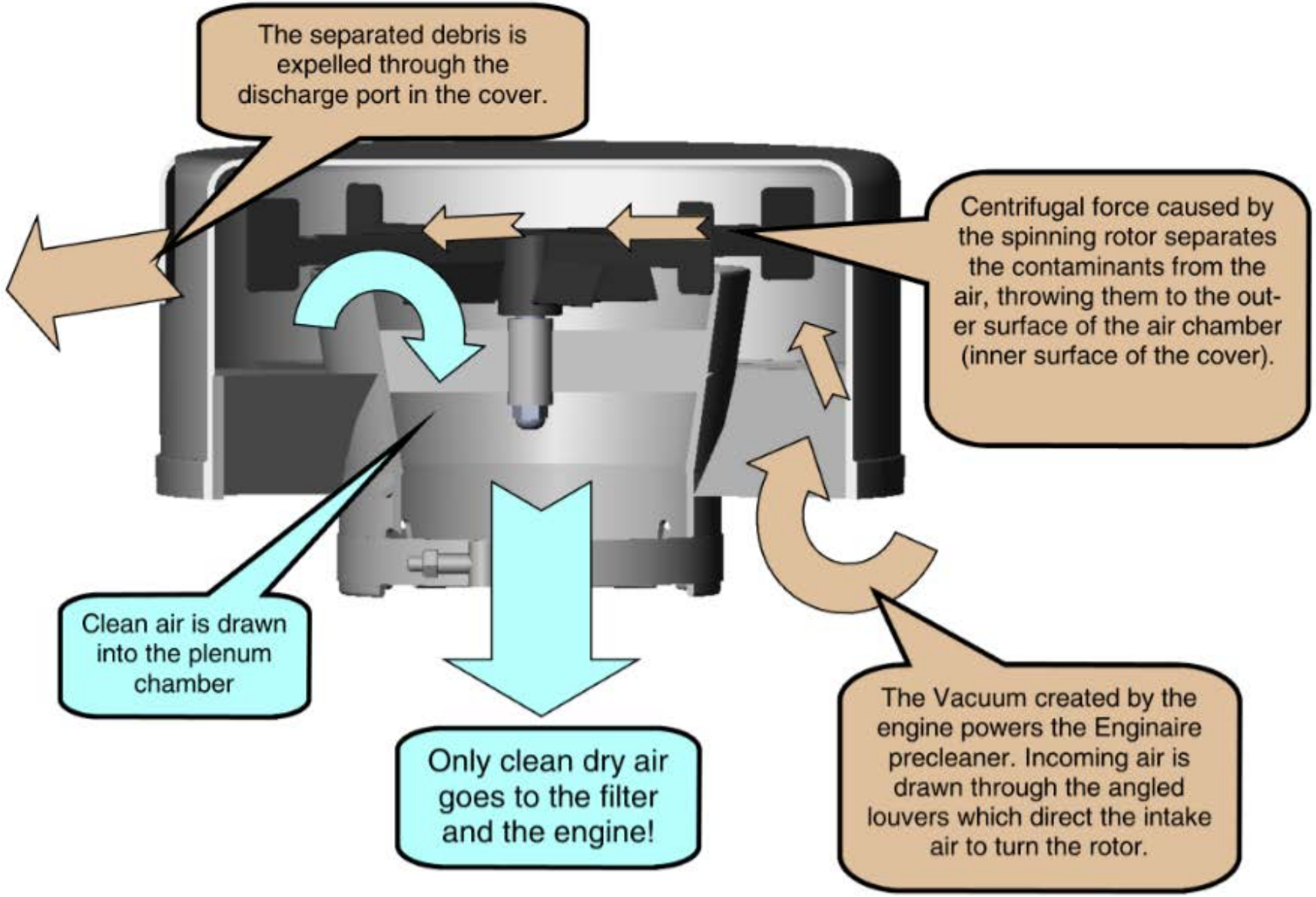
BEST

- Pre-cleaner + HEPA H13/14 filters + pressurised cabin + regular inspection & maintenance + effective cleaning.

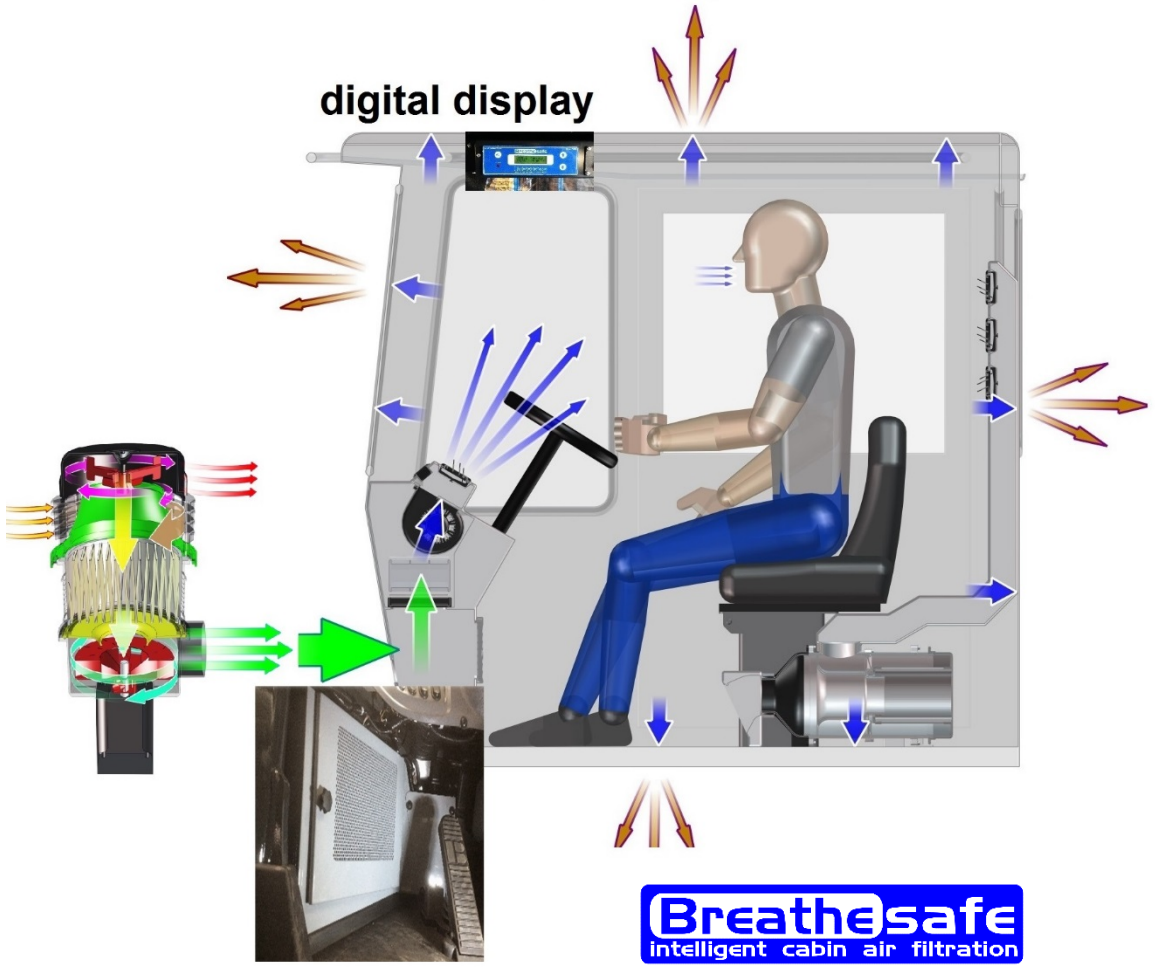
Pre-cleaning



Pre-cleaning



Return Air Filtration

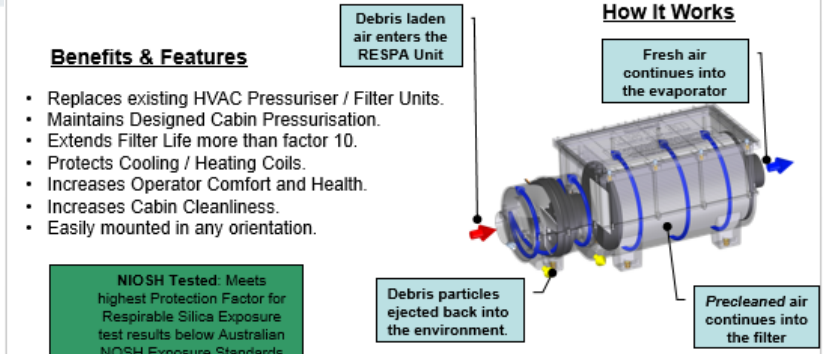


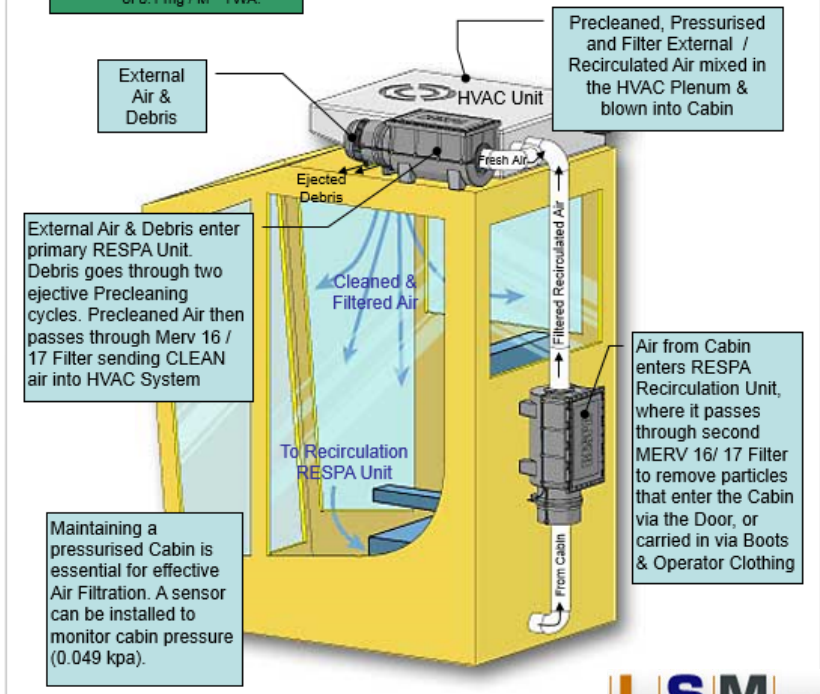
Benefits & Features

- Replaces existing HVAC Pressuriser / Filter Units.
- Maintains Designed Cabin Pressurisation.
- Extends Filter Life more than factor 10.
- Protects Cooling / Heating Coils.
- Increases Operator Comfort and Health.
- Increases Cabin Cleanliness.
- Easily mounted in any orientation.

NIOSH Tested: Meets highest Protection Factor for Respirable Silica Exposure test results below Australian NOSH Exposure Standards of 0.1 mg / M³ TWA.

How It Works





SY-KLONE INTERNATIONAL

LSM TECHNOLOGIES PTY LTD .... On the Move

RESPA- HVAC Precleaner Pressuriser + Filtration Technology

Issues

1. Filters that are not minimum HEPA H-13/14 / Grade 3
2. Management of dust brought into cabin (clothes, boots, incoming air from opening / closing door)
3. Effective, ongoing maintenance of seals and filters
4. Secondary exposures (tapping out, blowing out, sweeping out)
5. Education and awareness. Workers won't control effectively unless they know why control is important
6. COST to retro-fit

Cost vs Benefit

- Significantly increase operational life of HVAC system
- Reduce maintenance and cleaning of HVAC
- This increases equipment availability (reduce downtime for AC cleanout and replacement)
- Improved working environment for operators
- Reduced exposure to contaminants

Some aspects to look at

1. Do workers understand the risk?
2. Signs of dust ingress (horizontal surfaces, vents, floor)
3. Door seals and windows. Are they in good condition?
4. Filter type (HEPA?) Are they inspected? How often?
5. How is cabin cleaned? How often?
6. Is cabin pressure tested / leak tested?
7. Personal monitoring records (evidence of exposure?)

Summary

- Don’t take cabin integrity as a ‘given’
- Ensure filtration of incoming and recirculating air effectively captures respirable-fraction dust
- Regular inspection and maintenance of cabin, air-conditioning system, door seals, filters
- Cabin cleaning methods must be appropriate and not increase exposure risk

Acknowledgements

LSM TECHNOLOGIES PTY LTD
.... On the Move

www.lsm.com.au

Breathesafe
intelligent cabin air filtration

www.breathe-safe.com.au

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