

Aggregate Cab Air Quality Case Study



Reduce Silica Exposure and Increases Operator Alertness with ISO 23875-Compliant RESPA® System

Problem

Daily operations at aggregates sites and quarries produce a significant amount of dust during the extraction, processing, and transportation of aggregates and natural resources. Byproducts of operations may produce harmful respirable particulate, such as silica. **Long-term exposure to harmful respirable dust may cause chronic lower lung diseases, including silicosis and lung cancer.** In addition, dust impacts machine performance, resulting in downtime, higher maintenance costs, and increased Total Cost of Ownership (TCO) for a company's heavy machinery.

Solution

To support occupational exposure reduction programs, a global aggregates company implemented a field test of ISO 23875-compliant cab air quality systems on two pieces of heavy equipment. ISO 23875 is a cab air quality standard that identifies engineering requirements, including filter efficiency, safe CO₂ levels, and pressurization levels, to improve air quality inside operator cabs. Implementing ISO 23875 with compliant cab air quality systems provided the site with health, safety, and operational benefits.



Benefits

- **Reduced operator fatigue** by maintaining CO₂ at a low level
- **Reduced exposure to harmful respirable dust, including respirable crystalline silica (RCS), to levels below permissible limits**
- Ensuring CO₂ and dust are managed through **continuous cab pressurization, fresh air exchange, and real-time monitoring**
- **Cleaner machine cabs**, resulting in less dust and debris impacting sensitive controls and components, potentially extending service intervals and the life of air conditioning components, such as the evaporator core

The Basics of ISO 23875

ISO 23875 is a cab air quality standard that outlines engineering controls and performance requirements to improve air quality in operator cabs, including:

- **Defined CO₂ levels**
- **Recirculation system efficiency**
- **Increased filter efficiency requirements**
- **Defined pressurization requirements**
- **Real-time cab monitoring**

THE BENEFITS OF CLEAN AIR:

"Equipment stays cleaner inside. Machine operator states 'air seems to be more fresh'. He has noticed his energy level throughout his 10 to 11 hour day seems more consistent, not the peaks and valleys throughout the day."

Site Manager,
Aggregate Quarry

System Installation and Integration

Sy-Klone RESPA cab air quality fresh and recirculation systems with HEPA filters and the RESPA Advisor+ (CO₂ and pressure monitor) were specified and installed on a haul truck and wheel loader. The process, followed from pre-installation through long-term performance measurement, included:

- Machine cab inspection and measurement prior to installing cab air quality systems to establish a comparative baseline
- Inspection, identification, and sealing of air leaks inside the cabs
- Short-term performance measurement and testing immediately following the installation of the cab air quality systems
- Long-term performance measurement and re-testing of the machines eight months after the cab air quality system installations



Haul Truck: Engineering Controls



OUTSIDE CAB

- **RESPA CF2** Powered Fresh Air Precleaner/Filter/Pressurizer with HEPA filtration



INSIDE CAB

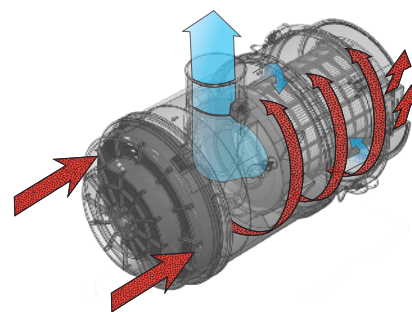
HEPA recirculation filtration cleans air as it returns to the HVAC mixing plenum, and monitor shows realtime CO₂ and pressure status.

- **RESPA FFX2** (2 units) Non-Powered Recirculation Air System with high-efficiency HEPA filtration
- **RESPA Advisor[®]+** CO₂ and Pressure Monitor



RESPA[®] CF2

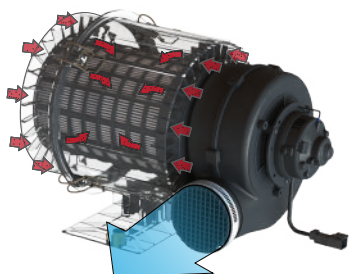
How fresh air system works



1. Dirty air enters and is whipped into a cyclone
2. Heavier-than-air debris is flung against outer wall
3. Debris is ejected from the system
4. Only filtered, precleaned air goes to HVAC system and pressurizes cab

RESPA[®] PFX

How recirculation filtration system works



Wheel Loader: Engineering Controls

OUTSIDE CAB

- **RESPA CF2** Powered Fresh Air Precleaner/Filter/Pressurizer with HEPA filter



INSIDE CAB

Standalone recirculation purification system continuously cleans air with a high-efficiency HEPA filter, and monitor shows realtime CO₂ and pressure status.

- **RESPA PFX** Powered Recirculation Air System with HEPA filtration
- **RESPA Advisor⁺** CO₂ + Pressure Monitor

Test Results

Following the ISO 23875-compliant installation, both the haul truck and wheel loader showed significant improvements to air quality and passed all ISO 23875 engineering control tests, including CO₂, dust decay, external system leakage, and cab pressure tests. Approximately eight months after the installation, both machines were tested again. The air quality improvements were sustained and the haul truck and wheel loader again passed all ISO 23875 engineering control tests. **Silica exposure is consistently below Permissible Exposure Limit (PEL).**

	CO ₂ Test	Dust Decay Test	External System Leakage Test	Cab Pressure Test
ISO 23875 Requirement	CO ₂ concentration must be less than ambient CO ₂ concentration plus 400 PPM. Ambient CO ₂ at test site was 455 PPM, so 954 is max allowable.	Dust decay must be under two minutes.	Dust concentration not to exceed 25 µg/m ³ .	Minimum cab pressure 20 Pa Maximum cab pressure 200 Pa
Haul Truck Results	Status: PASSED	Status: PASSED	Status: PASSED	Status: PASSED
Wheel Loader Results	Status: PASSED	Status: PASSED	Status: PASSED	Status: PASSED*

*Pressure was below max threshold at low fan speed, however, exceeded 200 Pa at medium and high speeds.

Conclusion

Cab air quality in the haul truck and wheel loader has been significantly improved with operators experiencing increased productivity, alertness, improved comfort, and much cleaner cabs. In addition, the operator exposure level to silica and other harmful dust particulate has been dramatically reduced. Read the complete case study including test reports at <https://www.sy-klone.com/blog/2022/05/18/case-study-aggregate>

The Importance of Dust Decay Rate

The majority of the airflow in the cab is provided by the recirculation system. Fresh air precleaning and filtration is just the first step. Harmful particulate is also entering the cab airflow through other methods:

- The door or window is opened
- Operator enters with dust on clothing and boots
- Dust built up in upholstery puffs out as operator moves on the seat
- Operator movements disturb dust that has settled in the cab

When dust enters the cab, the length of TIME it takes for the air quality to return to the Permissible Exposure Limit (PEL) is called the decay rate.

Without high-efficiency recirculation filtration that can't be bypassed, harmful dust can re-enter the airflow, and it takes a long time to be gradually diluted by the fresh air entering the cab.

"I really feel from my ongoing conversations with the operators that this has been an asset to the machines' operators in their alertness and ability to stay focused."

**Site Manager,
Aggregate Quarry**