The genesis of ISO 23875 and its impact on heavy mining equipment operator enclosure air quality

Part 1

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ABSTRACT

Mining machines frequently operate in environments with high concentrations of respirable crystalline silica (RCS) dust. Overexposure to RCS poses a substantial health risk to mining machine operators, leading to lung diseases. The International Standards Organisation (ISO) 23875:2021 standard establishes a uniform method and defines the performance metrics necessary to ensure acceptable air quality for mining machine operators. This article series delves into the historical development and transformative influence of the ISO 23875 standard on the air quality within heavy mining equipment (HME) operator enclosures.

INTRODUCTION

Mining machines frequently operate in environments with high concentrations of respirable crystalline silica (RCS) dust. Overexposure to RCS poses a substantial health risk to mining machine operators, leading to lung diseases. Research indicates that existing technologies are highly effective in reducing silica exposures when appropriately applied to heavy equipment cabs.[1-4]

To reduce the risk of overexposure to RCS, the International Standards Organisation (ISO) Technical Committee- (TC-) 82 Mining created ISO 23875:2021 to provide a uniform method, and define performance metrics, to ensure acceptable air quality for mining machine operators. This standard is crucial for implementing consistent and effective measures across the mining industry, to safeguard the health of operators exposed to RCS.

This article, the first in a three-part series, explores the historical development and transformative influence of the ISO 23875 standard on air quality within heavy mining equipment (HME) operator enclosures. We will delve into the roots of ISO 23875 and its inception, and acknowledge the individuals and institutions instrumental in laying the foundational research on which it is built.

Respiratory diseases are inherent in mining. Historically, mineworkers were left to fend for themselves. A recent landmark class action suit in South Africa resulted in a significant settlement for mineworkers with silicosis.[5] Mining companies are now being held responsible for worker overexposures, which have resulted in lung disease and, in some cases, death.

Litigation pressure underscores the need for standardised best practices in the international mining industry to address operator enclosure air quality. Far more than local and national regulations, effective, industry-adopted international standards heavily influence machine specifications, machine manufacturing, and health and safety practices.

Creating effective international standards is only the first step. To comply with the standard, mining machines require retrofitting or re-engineering to shield operators from respirable dust exposure. Research performed over the past 25+ years, by the US-based Pittsburgh Mining Research Division (PMRD) of the National Institute for Occupational Health and Safety (NIOSH),[a] revealed what engineering controls are necessary to control dust ingress into an operator enclosure, including continuous positive cab pressurisation and high-efficiency filtration on intake, and recirculation airflows within the ventilation system.[1]

While research identified the engineering path required, technologies were initially inadequate. However, in 2000, Sy-Klone International patented a powered particle separator, which removed particles larger than 5 µm from heating, ventilation, and air conditioning (HVAC) intake airflows without the use of a mechanical filter, at greater than 90% efficiency. This made the use of high-efficiency filtration over extended service intervals possible in high dust concentration mining environments. Further advancements in filter technology, allowing for increased filter life and durability, came in 2007, when Sy-Klone International applied nano fibres to base filter media, resulting in the first particle-shedding, high-efficiency intake and recirculation filters for mining HVAC intake air systems.[2] These innovations were evaluated by the PMRD of NIOSH[3] and the Queensland Government in Australia, and contributed substantially to the development of compliant air quality in operator enclosures in real-world mining environments.

In 2009, the Queensland Mine Inspectorate performed a groundbreaking real-world evaluation, the RESPA® Trial 2009,[6] which demonstrated the technology's contribution as an engineering control to reduce and maintain RCS dust concentrations below threshold limits.

During this time, research by the PMRD validated additional engineering control technologies, which, as subcomponents to the operator enclosure air quality system, contribute to the continuous delivery of acceptable air quality in real-world mining environments.[4]

In 2012, the International Society of Environmental Enclosure Engineers (ISEEE) was established as a non-profit organisation, filling a need in the industry to focus on real-world testing, certification of air quality performance, and education around operator enclosure air quality. The ISEEE's research emphasised the importance of intake airflows and dilution of operator-generated CO_2, and identified inadequacies in ventilation systems that lacked adequate intake airflow in their HVAC designs.[7,8]

By 2015, the ISEEE had initiated the Advanced Cab Theory Workshop (ACTW),[9] which was a culmination of years of proprietary research as well as research performed by NIOSH/ PMRD and others. The workshop is designed to educate all stakeholders responsible for operator enclosure

[a] Under NIOSH, the Pittsburgh and Spokane Research 'Centers' were renamed the Pittsburgh Research Laboratory and Spokane Research Laboratory. Both laboratories currently reside under NIOSH's Office of Mine Safety and Health Research.

air quality. During the workshops, a unique cab is utilised – specifically designed to educate about cab theory, multivariable fluid dynamics, engineering controls, and air quality monitoring, and to provide experience on how the cab functions as a complete system to provide acceptable air quality to the operator.

Mining equipment manufacturer, Epiroc (https://www.epiroc.com/en-za), sent one of its cab design engineers to participate in the ACTW in 2015, which led to a change in their understanding of cab design. This change caught the attention of the ISO TC-82 Mining representative who, in 2018, asked to use the content of the ACTW in the development of an operator air quality standard for the mining industry. Subsequently, a working group (ISO TC-82 Mining Working Group Nine (WG9)) was formed. The first standard developed by WG9 was ISO 23875:2021.

The ISO Working Group comprised 27 subject matter experts from 10 mining countries, including occupational hygienists, academics, mining machine manufacturer HVAC experts, cab design engineers, and filtration specialists.

The standard draft received comments from the Earth Moving Equipment Safety Round Table (EMESRT), the Queensland Mine Inspectorate, the PMRD, the Mine Safety Health Administration, the American Industrial Hygiene Association (AIHA) Mining Working Group, members of Australia's ME18 – Australian mirror committee to ISO TC-82 mining – and the Australian Institute of Occupational Hygiene (AIOH). Every effort was made to be inclusive.

The standard was published in February 2021, after receiving 100% positive votes during multiple ballots. Since publication, the standard has been adopted as a national standard by the European Union (EN/ISO 23875:2022), Sweden (SS/EN/ISO 23875:2022), and Australia (AS/NZ ISO 23875). This widescale adoption of the standard is a victory in our efforts to improve health outcomes for mineworkers.

The second article in this series, 'Technical aspects of ISO 23875', will examine the content of the standard, the structure, and its practical relevance to heavy equipment manufacturers, retrofit engineers, maintenance personnel, machine operators, occupational hygienists, and corporate leadership.

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