WHY PARTICULATE MATTER MATTERS

And what firestop-products have to do with it

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INTRODUCTION

Executive Summary

Despite the well-known threat that airborne contaminants pose to IT-equipment, many data centers unwittingly design risk into the facility with the selection of traditional firestopping materials such as coated firestop batts. Repenetration of these materials to accommodate frequent cabling changes releases high concentrations of particulate matter into the airflow. Specify fiber-free firestopping products to prevent failures due to airborne contamination.

CONTENT

PARTICULATE CONTAMINATION

Endangers reliability and energy efficiency

Modern IT equipment continues to get smaller and smaller, improving efficiency but also increasing susceptibility to problems associated with airborne contaminants in the data center environment:

- Overheating and resultant equipment failure due to particulate accumulation in vents, heat sinks, filters and fans
- Malfunction of mechanical interfaces of devices (e.g. ports and connection slots)
- Reduced life span of electronic equipment
- Reduced life span of cooling equipment / frequent filter changes
- Lower thermal efficiency and increased cooling costs

> “Particulate contamination can increase a data center’s power demand by 2% or more.” [3]

Most design guidelines recommend data centers be classified and operated as clean room class 8 environments acc. to ISO 14644-1 (the international standard for classifying the cleanliness of the air in cleanrooms and clean zones). This means particulate matter concentrations should not exceed the following values at any measuring point within the white space*:

	Limit [number of particles per m³] for particles per size		
ISO Class	**≥0,5 µm**	**≥1,0 µm**	**≥5,0 µm**
ISO 8	3.520.000	832.000	29.300

Fig. 1: ISO 14644-1 particulate matter limits in data centers as per ASHRAE recommendations [2] [5]

*number and position of measuring points acc. ISO 14644-1 depends on room size and critical activities within the clean room

The importance of cleanliness is apparent in the variety of methods employed to prevent airborne contamination:

- Regular professional cleaning by specialized data center crews
- Use of anti-contamination mats
- Over-pressurization of environments with sensitive equipment
- Use of High Efficiency Particulate Air (HEPA) filters
- Separated areas for unpacking cardboard

Owners, designers and operators consistently weigh the trade-offs between cost, safety and particulate contamination when selecting construction materials during the design process.

> “Contamination prevention is just as important in design consideration as power, cooling, and security.” [3]

Though achieving a 100% particle-free environment is neither feasible nor necessary, respecting recommended contamination limits helps protect sensitive IT equipment. Unfortunately, traditional firestopping products often employed as per standard building practices introduce a source of contaminants that may compromise data center operations, leading to energy waste and even to unplanned downtime.

CABLING CHANGES THROUGH TRADITIONAL FIRESTOPPING PRODUCTS

A potential source of contamination

Where services such as pipes or cables penetrate through partition walls, firestopping products must reestablish the integrity of the wall. In many parts of the world, low-cost firestop mineral wool boards (commonly known as “firestop batt”) are the most widespread method of firestopping such penetrations.

The firestop batt is made of fibers of metallic ore and igneous rock and is effective in preventing the transmission of heat, flames, toxic smoke and other gases. Although generally perceived to be harmless because a layer of coating encloses the fibers once initial installation is complete, these boards actually present a significant particle emission source in many data centers.

Fig. 2: Coated firestop mineral wool board [6]

Fig 3: Particulate sizes in firestop batts vary widely according to manufacturing process, averages range between 2 and 10 µm diameter [7] [8]

The quick evolution of IT and telecommunication technology means that data cables are constantly being added, changed or removed – even where they cross the white space envelope. To accommodate these changes, maintenance personnel must cut or tear the firestop batts back out – releasing a wide spectrum of fibers of various sizes into the data center environment.

MEASURING PARTICULATE RELEASE

During firestop board repenetration

The Fraunhofer IPA Institute (Stuttgart), specialized in clean room environments, assessed particle concentrations released when repenetrating such traditional firestop systems. Unwilling to permit coated boards inside its highest level cleanroom for fear of damaging the particle counting equipment used for its official measurements; Fraunhofer nevertheless allowed the batts to be repenetrated in its Class 6 cleanroom environment with turbulent airflow.

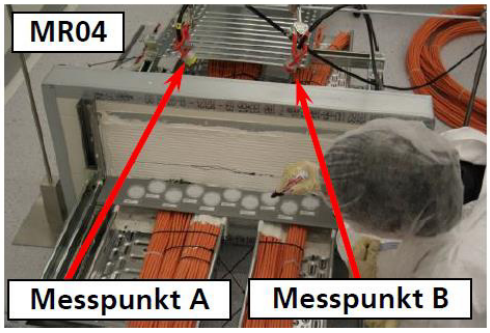

Fig. 4: Measurement of particulate release during firestop board repenetration [9]

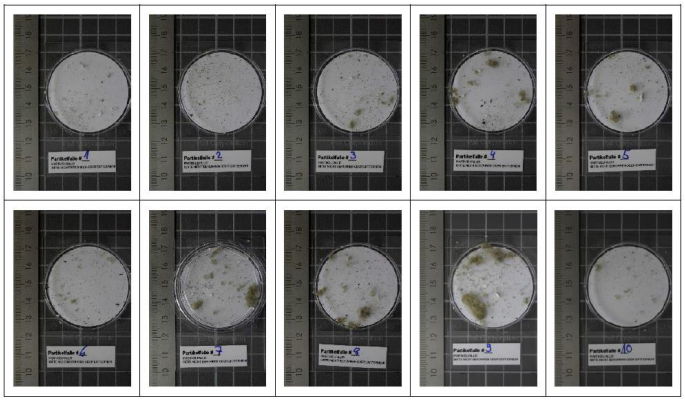

Fig. 5: Measurement of particulate release during firestop board repenetration [9]

A second accredited institute also quantified the emission of particles which entered the airflow during installation and repenetration of firestop mineral wool boards. The results were evaluated according to TRGS 519 in combination with BGI/GUV-I- 505-46 and VDI directive 3492 to ensure only fiber release from the board was considered.

Fig. 6: Cutting and fitting mineral wool board [11]

During a standard cable tray repenetration, the institute measured particle concentrations up to 2.5 times higher than recommended limits for data centers (penetration ca. 1000 x 800 mm):

	Number of particles (length > 5 µm, diameter < 3 µm) [fibers/m³]
Limit acc. ISO 14644-1 Class 8	29.300
Airborne particles measured (repenetration via cutting)	75.250

Fig. 7: Cutting and fitting mineral wool board [10] [11]

These measurements suggest that a significant amount of mineral wool fibers could be released into the airflow during each cabling change. It is not feasible to completely control fiber dust emissions at the source during repenetration or maintenance activities and even temporary enclosure of the working area will not entirely contain all the particles. When cutting and removing the batts, fine fiber particles will be released into the airflow, where they could quickly accumulate in electronic equipment and ultimately compromise data center operations.

SELECT FIBER-FREE PRODUCTS

To reduce the risk of airborne contamination during cabling maintenance activities

> “The key to keeping airborne contaminants out of the data center is to avoid bringing them in.” [12]

It is crucial to select products which not only ensure cleanliness at initial construction, but also with each subsequent cabling change. Eliminate future contamination sources during the design phase by selecting fiber-free firestopping materials designed to meet the needs of dynamic cabling environments.

Firestop pathway devices such as the Hilti Speed Sleeve not only reduce the risk of airborne contamination, but also reduce the amount of costly air escaping the white space envelope.

For larger openings to accommodate multiple services such as cable trays, busbars or ducts, select reusable fiber-free products such as Hilti Firestop Blocks (CFS-BL).

The Fraunhofer Institute also tested the Hilti Firestop Block and assessed the particle emission behaviour, concluding the blocks are suitable for cleanroom applications from “class 4” to “classe 9” (acc. ISO 14644-1). [13]

Suitable fiber-free products such as those mentioned above will not only reduce the release airborne contaminants during cabling maintenance, they also reduce total facility cost and enhance security by eliminating or reducing the need for specialized maintenance personnel during cabling changes.

From a long-term perspective, the use of cleaner technologies designed for repenetration not only ensures a longer equipment lifespan and higher energy efficiency, but also reduces maintenance efforts while keeping the data center flexible for future growth.

Fig. 8: Hilti Speed Sleeve (CFS-SL / CP 653 BA)

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CONCLUSION

About the Author:

Livia Nogueira Divino received her M. Sc. Chemical Engineering at the University of Mannheim, where she specialized in environmental management. After gathering professional experience at different companies in various assignments related to product development, production planning and quality management, Livia joined Hilti as a development engineer in the Technical Service team in 2015. She currently works developing Firestop Solutions for mission critical facilities and for challenging Energy and Industry environments, like Data Centers.

About Hilti:

Hilti was founded in 1941 as a family-owned company and its team includes nearly 20,000 members in more than 120 countries. Together with nonstructural field engineers, fire protection specialists and third-party agencies, Hiltis in house fire protection engineering teams test every firestop product to the highest standards. Hilti has over 1000 tested systems that provide firestopping solutions for joints and penetrations through fire-rated walls or floors.

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