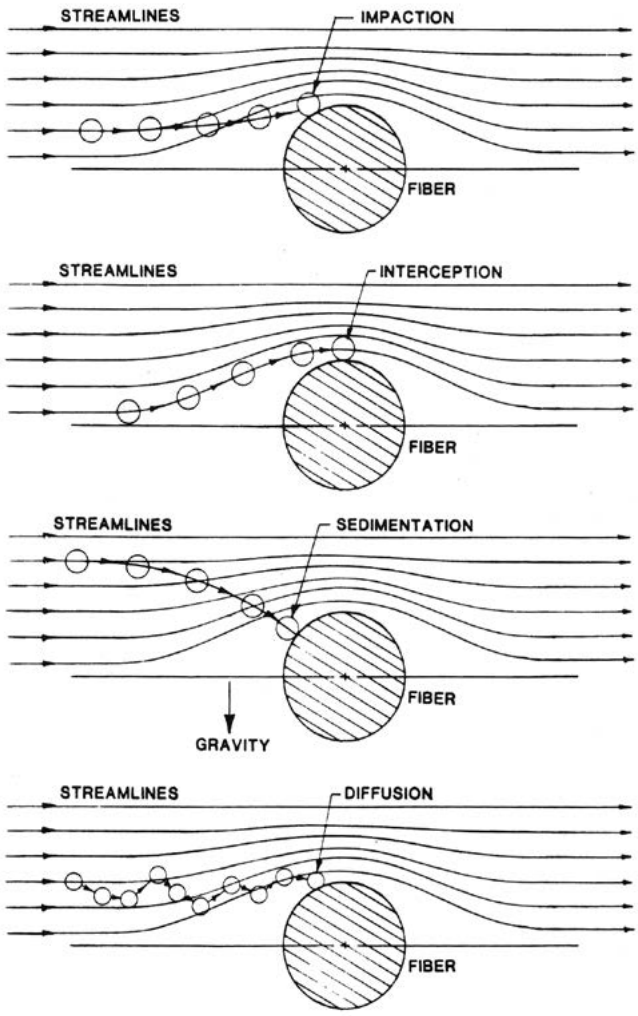
Technical Advisory
Release of Filtered Particles

Are Filtered Particles Released from High Efficiency (HE) Filters During Change-Out?

Recently, we have received several questions concerning the potential release of particulate matter from our PA1FG High Efficiency Filter for our PA20 PAPR (NIOSH Approval No. TC-21C-0765) when the filter is changed. Before exploring that issue, let's review how these filters work.

High Efficiency (HE) filters like the PA1FG are mechanical type filters. Mechanical filters collect particles through a number of different mechanisms, including impaction, interception, gravity and diffusion. Impaction occurs when particles leave a streamline due to their inertia and are trapped against a filter fiber. Once captured, attractive forces keep the particle against the fiber. Interception occurs when particles traveling on air streamlines are carried close enough to the filter fiber to be captured. Gravity causes settling of particles which can bring them close to a fiber for capture. This process is called sedimentation. Diffusion occurs when very small particles undergo random movements as they are bombarded by air molecules. If this Brownian motion brings them near a filter fiber, then they are captured.



From Japuntich, Daniel A., Respiratory Particulate Filtration. J. Ind. Soc. Respir. Prot. 1984; 2(1):137-169

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Every filter exhibits what is called the most penetrating particle size. At some particle size, collection is at a low point. For all particles larger or smaller than this size, the collection efficiency will be higher. This phenomenon occurs because the larger particles tend to be collected by impaction and interception, and the smaller particles are collected by diffusion. At a certain particle size, these processes reach a minimum efficiency, and this is the most penetrating particle size.

For most HE filters, the most penetrating particle size is about 0.2 – 0.3 micrometers count median diameter. Bullard PA1FG HE filters are 100% tested against particles of this size, and the minimum acceptable efficiency is 99.97%.

To put this in perspective, bacteria such as anthrax are about 0.5 – 1.0 micrometers in diameter, and bacillus type bacteria such as tuberculosis (rod–shaped) are about 1.5 – 2 micrometers long. Viruses range in size from 0.02 – 0.3 micrometers. HE filters can be used for protection against biological hazards such as bacteria, viruses, mycoplasmas, rickettsiae, and fungi.

Now, let's examine the question at hand, and that is whether high efficiency filters will release the particles trapped on the filter when the filter is replaced. Particles collected on respirator filters are trapped in the filter matrix and are not easily released from the upstream (outward) side of the filter. In our experience, particles are only released from the upstream side of a filter if the filter is violently agitated, such as being banged on a desk. No particles will be able to penetrate to the downstream side after capture.

There is a published research study that looked at similar issues. This paper, published in 1997, examined the release of particles from respirators without exhalation valves if the respirator wearer sneezes or coughs.[1] It was shown that no release of particles below 1 micrometer in size occurred at relative humidities over 35%, even if the air velocity through the filter were as high as 300 centimeters per second, which is about 37 times the air velocity through the respirator during heavy workload conditions. If the particles were not trapped in the respirator filter, they would have been blown off the outside of the filter at that velocity. The Bullard PA1FG filter would be expected to behave in the same way, and not release any particles.

Based on the results of this study and our own experience with respirator filters, there should be no concern about the release of particles when changing out the PA1FG filter. No special precautions are needed, other than to avoid banging the filter or dropping it on the floor. No dust particles should "fall" into the blower mechanism because the particles are trapped in the filter. In addition, the downstream side of the filter, which is the side facing the blower mechanism, will not have any particles on it. Therefore, there is no potential at all for this event to occur.

If you would like any further information on Bullard respiratory protection products, please contact Bullard Customer Service at 877-BULLARD or info@bullard.com.

[1] *Qian, Y., K. Willeke, S.A. Grinshpun, J. Donnelly: Performance of N95 Respirators: Reaerosolization of Bateria and Solid Particles. Am. Ind. Hyg. Assoc. J. 58: 876-880 (1997).*

Americas:
Bullard
1898 Safety Way
Cynthiana, KY 41031-9303 • USA
Toll-free within USA: 877-BULLARD (285-5273)
Tel: +1-859-234-6616
Fax: +1-859-234-8987

Europe:
Bullard GmbH
Lilienthalstrasse 12
53424 Remagen • Germany
Tel: +49-2642 999980
Fax: +49-2642 9999829

Asia-Pacific:
Bullard Asia Pacific Pte. Ltd.
LHK Building
701, Sims Drive, #04-03
Singapore 387383
Tel: +65-6745-0556
Fax: +65-6745-5176

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