

# QUANTITATIVE RESPIRATOR FIT TESTING

## FIT TESTING SERIES 95 RESPIRATORS WITH AND WITHOUT N95-COMPANION™ TECHNOLOGY

APPLICATION NOTE RFT-024 (A4)

### Introduction

Ambient Aerosol Respirator Fit Testing is typically accomplished using a Condensation Nuclei Counter (CNC) based instrument, like TSI's PortaCount® Respirator Fit Tester. This is also referred to as Quantitative Fit Testing (QNFT). By definition, the Fit Factor (FF) of a respirator is:

$$FF = C_{out} / C_{in}, \text{ where}$$

- $C_{out}$  is the concentration of particles outside the mask (ambient concentration)
- $C_{in}$  is the concentration of particles inside the mask

As background, particles that can potentially get inside a mask via one or more of the following:

- Leak through the face seal
- Penetration through a filter
- Generated by person (i.e., coughing, breathing, and smoking)
- Shedding (i.e., from inside of respirator or tubing)

For most half-face and full-face elastomeric masks, they include a HEPA filter with a 99.97% efficiency. This means the penetration through the filter is negligible and most of the particles penetrating the mask would come from a leak. However, with N95 masks rated at 95% efficiency, we can no longer disregard the penetration through the filter as it could be up to 5%, which would definitely impact the fit factor. This phenomenon could actually cause fit tests to fail, even if the face seal is excellent.

To address this situation, TSI has developed N95-Companion™ Technology for quantitative fit testing for N95 respirators.

Recently new CNC-based Respirator Fit Tester vendors claim they can test “most” N95 respirators without N95-Companion™ Technology. This application note looks at the test results of some N95 respirators with and without N95-Companion™ Technology.



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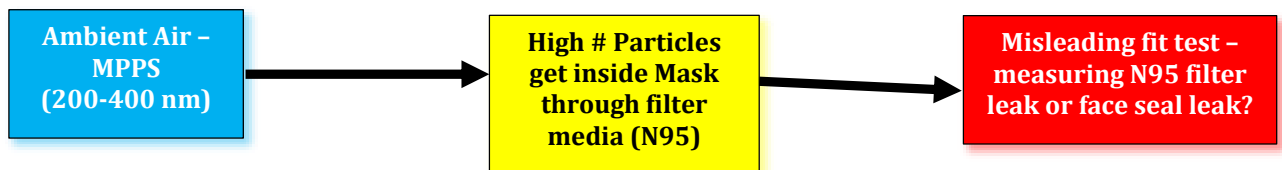
## N95-Companion™ Technology

With QNFT, ambient aerosols are used to challenge the respirator mask. TSI's N95-Companion uses an electro-mechanical method to challenge a mask with particles only in the range that will challenge the face seal and not the filter.

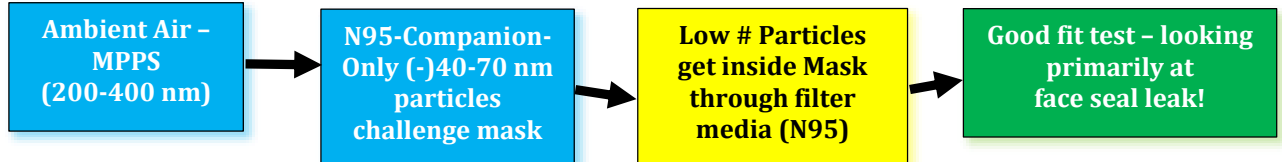
For most filters, the Most Penetrating Particle Size (MPPS) is in the 200 to 400 nanometer (nm) range. If a mask with an N95 filter is challenged with ambient air, a significant number of particles could get inside the mask, simply through the filter media, and this would fail a good fitting respirator. So, the N95-Companion removes particles in the MPPS range. In fact, it removes particles so only the negatively charged ~40 to 70 nm particles get through the N95-Companion and are measured by the CNC. In effect, this means that only the negatively charged 40 to 70 nm particles are used to challenge the mask. Most of these particles will get caught in the filter media, again, meaning that the primary mode of penetration would be through the face seal.

Additionally, opposite charges attract and if a particle has a charge, it will be attracted to the electrically charge filter media (Electret), thus getting filtered out and not penetrating through the mask. Again, the N95 is working to reduce penetration through the mask, so the fit test only challenges the face seal. For more specific information on particle charging and N95 masks, refer to TSI Application Note RFT-007. This is shown pictorially below:

Without N95-Companion:



With N95-Companion:



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## Test Plan and Data Collected

To find out more about fit testing N95 Masks, TSI conducted tests comparing results with and without the N95-Companion to see the impact of the N95-Companion in real-world testing. Ambient aerosol was used as the challenge.

Specifically, TSI has conducted comparison testing with the PortaCount Model 8030 (no N95-Companion) vs. Model 8038 (with N95-Companion) on a variety of commercially available N95 masks. The tests were conducted as paired/same donning quantitative fit tests. The test results are shown in the table below.

Paired Fit Test Results using PortaCount Pro Model 8030 and PortaCount Pro+ Model 8038 with N95-Companion Technology						
MFG	Model	Type	Media	8030 Overall Fit Factor	8038 Overall Fit Factor	Notes
3M	VFLEX 9105	N95	Electret (only)	91/FAIL	200+/PASS	Failed a Good Fit
3M	Aura 9210+ (tri-fold)	N95	Combo	514/PASS	200+/PASS	Good Fit
3M	1870 (tri-fold)	N95	Combo	235/PASS	174/PASS	Good Fit
3M	Aura 1870+ (tri-fold)	N95	Combo	327/PASS	177/PASS	Good Fit
Sperian	One-Fit NBW95	N95	Electret (only)	88/FAIL	200+/PASS	Failed a Good Fit
Sperian	SAF-T-FIT (duckbill)	N9510F-M	Electret (only)	72/FAIL	200+/PASS	Failed a Good Fit
Moldex	2200N Series	2200N95	Combo	238/PASS	200+/PASS	Good Fit
Moldex	2200N Series	2207N95	Electret (only)	81/FAIL	200+/PASS	Failed a Good Fit
Moldex	2300N Series	2300N95	Combo	418/PASS	200+/PASS	Good Fit
Moldex	2300N Series	2307N95	Combo	104/PASS	200+/PASS	Almost Failed a Good Fit

## Analysis and Results

With the PortaCount Model 8038 (with N95-Companion), every mask passed the fit test, showing that all masks had good fits. Conversely, the PortaCount Model 8030 (no N95-Companion) failed numerous respirators that had perfectly good fits. Why? Most likely because too many particles penetrated through the mask filter media, thus not really testing face seal—the test of the respirators fit.

From the data above, the test results from the 8030 show that most N95 masks with Electret filter media fail whereas most with electret/mechanical (i.e., Combo) media pass. While not proven, this is likely because the Combo filter media used in N95 masks is higher than 95% efficient. The efficiency of N95 rated mechanical filter media can vary greatly from manufacturer to manufacturer, and from batch to batch of manufactured products. Electret-only N95 masks make up an estimated 30% of the market and growing.

## Conclusion

The science and test results show that, with no N95-Companion (i.e. a CNC only fit tester), a significant number of fit tests will fail that should pass. In this test report, all N95 masks passed fit tests when tested with a CNC using N95-Companion technology.

These false failures will put a fit test administrator in the challenging position of looking for different masks, spending more time (re-)fit testing, and potentially purchasing additional masks that very well might fail again and again. At some point, this whole situation of using a CNC only without N95-Companion, might bring about an unneeded safety concern.

Why would a company risk the chance of failing a good fitting respirator?

A better approach is to fit test N95 masks with an N95-Companion, like TSI's PortaCount Model 8038, and confidently know that the fit test can be trusted.



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