NIOSH ON PORTACOUNT® RESPIRATOR FIT TESTER VS. CNP

APPLICATION NOTE RFT-009 (A4)

Why NIOSH uses Aerosol-based Fit Testing for Respirator Certification

In case you did not know it, NIOSH uses aerosol-based quantitative fit testing (QNFT) for certification of respirators. NIOSH does not use CNP (controlled negative pressure) instruments. Why is that? The CNP method is purported to be faster and cheaper. And CNP is OSHA-accepted just like aerosol methods.

The reason the NIOSH uses aerosol fit testing methods for certification of respirators is because of past research they themselves conducted. NIOSH compared both aerosol and CNP methods to actual human exposures and determined that aerosol methods are far superior to CNP.

NIOSH Research

In 1998, The National Institute for Occupational Safety (NIOSH) began a huge 2-part research project[1,2] to study six different quantitative respirator fit test (QNFT) methods. The objective of the study was to find out if the fit factors measured by any of the existing methods had what really counts; a relationship to actual respirator protection levels. In other words, which methods work, and which do not? Here is an excerpt from Part I[1]:

"Quantitative fit tests (QNFT) have been assumed to be predictive of the protection respirators would provide to a wearer in the workplace. Workplace studies have consistently found no correlation between quantitative fit factors and workplace protection factors. This article is the first in a series of three describing a study designed to compare the fit factors from six QNFT methods against the actual dose of 1,1,2 trichloro-1,2,2 trifluoroethane (Freon-113) received under the same laboratory conditions."

Part I[1] of the study involved study design. Part II[2] involved the actual measurements and analysis on half- mask respirators.

The six QNFT methods consisted of one controlled negative pressure (CNP) method and five aerosol-based methods using three different instruments. The reason that there were six methods tested, and only three instruments, was because the generated aerosol instrument was tested with three different mask sampling techniques and the ambient aerosol instrument was tested with two different exercise protocols. Here is a synopsis of the six methods.

Six QNFT Methods Used by NIOSH for this Study

Method Name	Method Description	Details	Instrument	Exercise Protocol
CHD	**Generated aerosol**	High flow, Extended probe	**Photometer**	**OSHA**
CLF	Generated aerosol	Low flow, Flush probe	Photometer	OSHA
EVD	Generated aerosol	Exhaled air sample	Photometer	OSHA
AA1	**Ambient aerosol**	Flush probe	**PortaCount**	**OSHA**
AA2	Ambient aerosol	Flush probe	**PortaCount**	17 Exercises
CNP	**Controlled negative pressure**	Std. adapter	**FitTester 3000**	**OSHA**

Of these six methods, only three are in everyday use; CHD, AA1 and CNP. The other “different” methods were chosen by the researchers because that is what researchers do. For the balance of this discussion, we’ll focus on CHD, AA1, and CNP.

CHD Method

The CHD method was chosen by NIOSH because it represents the “’Gold Standard” for QNFT. It is typically only found in research laboratories. It is the original technique developed at Los Alamos National Lab and is still considered the standard by which all other QNFT methods are evaluated. NIOSH currently uses this method with corn oil aerosol to certify CBRN (Chemical, Biological, Radiological and Nuclear) respirators used by emergency responders. The US Army currently uses the generated aerosol method to test and develop new gas mask designs. Generated aerosol systems are custom made, and therefore not available commercially.

AA1 Method

The AA1 method used an OSHA-compliant ambient aerosol fit test protocol. The instrument was a PortaCount Model 8020, which has since been replaced by the PortaCount Model 8030.

CNP Method

The CNP method used an OSHA-compliant fit test protocol and a controlled negative pressure fit tester called the FitTester 3000, which has now been replaced by the Quantifit™ instrument.

What NIOSH Did

The purpose of the study was to find out if any of the QNFT methods could predict actual human exposure to a gaseous hazard. Test subjects were fit tested and also exposed to Freon gas. The respirators were equipped with filter cartridges that prevent Freon from passing through, therefore any Freon detected in the test subject’s bloodstream had to be due to inhalation and respirator leakage.

Comparison of the different fit test methods was done by calculating a correlation coefficient based on the measured fit factors and measured Freon blood concentrations. A coefficient of 1.0 means that there is a perfect match. Coefficients above 0.8 are usually considered to be very good and those below 0.5 are considered poor. It is also necessary to compare coefficients to each other rather than simply looking at the value by itself because experimental uncertainties can shift the values, yet leave their relationship to each other intact.

The NIOSH results for half mask respirators (Part II of NIOSH study)

The generated aerosol method (CHD) came out on top with a coefficient of 0.81. This confirmed it as the Gold Standard.

The PortaCount fit tester method (AA1) was a close second with a nearly identical coefficient of 0.78.

The CNP method yielded an unimpressive 0.36.

NIOSH Results for Half Mask Respirators (Part II)

QNFT Method	Correlation Coefficient (R^2)
Generated Aerosol (CHD)	0.81
PortaCount Fit Tester (AA1)	0.79
Controlled Negative Pressure (CNP)	0.36

What about Full-Face Respirators?

The poor results for the CNP method with half face respirators was corroborated in 2002 when NIOSH performed similar experiments using full-face respirators[3]. Those results cannot be directly compared to the half mask results because the coefficients were shifted due to some unknown reason. However, the relative differences between the coefficients confirm the sub-par performance of the CNP method discovered in Part II for half mask respirators. Relatively speaking, coefficients for the aerosol methods far exceeded the CNP coefficient. For full-face masks, the CHD and AA1 methods had coefficients of 0.09 and 0.11 respectively. The CNP coefficient was essentially zero (< 0.01).

NIOSH Results for Full Face Mask Respirators

QNFT Method	Correlation Coefficient (R^2)
Generated Aerosol (CHD)	0.09
PortaCount Fit Tester (AA1)	0.11
Controlled Negative Pressure (CNP)	0

Additional NIOSH Research

In 2003, an unrelated NIOSH study showed a high correlation between PortaCount fit factors and worker exposure to airborne contaminants at a steel foundry[4]. The correlation for test subjects with PortaCount fit factors below 100 (the pass/fail level) was a very respectable 0.71. That helped convince NIOSH that the PortaCount fit tester method was also effective for identifying poor fitting respirators. In the context of occupational respirator fit testing, the identification of poor fitting respirators is arguably more important than predicting the protection level of good fitting respirators.

Conclusion

NIOSH is a first-class scientific organization that represents the cutting edge of respirator research. NIOSH research has validated the generated aerosol and ambient aerosol (PortaCount) fit test methods as being predictive of respirator protection levels on humans, and that the CNP method is not.

NIOSH is always working on improvements to the respirator certification process. They are currently proposing changes[4] that will add fit test requirements to the half-face respirator certification standard known as 42CFR84. The proposal is known as Total Inward Leakage (TIL) Testing. Based on the NIOSH research discussed above, and all the additional respirator knowledge NIOSH has accumulated, it is no surprise that the instrumentation called out in the TIL proposal is 100% aerosol based.

References

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4. NIOSH TIL (Total Inward Leakage) Proposal: http://cdc.gov/niosh/docket/archive/docket137.html

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