Industrial Hygiene in the Workplace

# Respiratory Protection

SPONSORED BY:

AIR SYSTEMS INTERNATIONAL

TSI® Knowledge Beyond Measure.

# Contents



Photo courtesy Accutec

# Advances in Respiratory Protection Program Management & Fit-Testing Systems

By: **Rob Brauch**, *Contributor*

When practicing industrial hygiene, many forms of instrumentation are used. Most measure some physical or chemical agent in real-time, for exposure assessment and adherence to regulated action levels, permissible exposure limits, STELs and ceiling levels. Some warn workers of an IDLH hazard, such as dangerous concentrations of toxic or explosive materials.

Instruments for EH&S measure to performance standards approved by ANSI, IEC or ISO to prove they meet accuracy, repeatability and precision expectations. For nearly 50 years, they have electronically stored data and provide detailed "time-history" records of the exposure. Imagine the time before that, when IH instruments only gave readings that had to be written down on paper—using archaic utensils like pens!

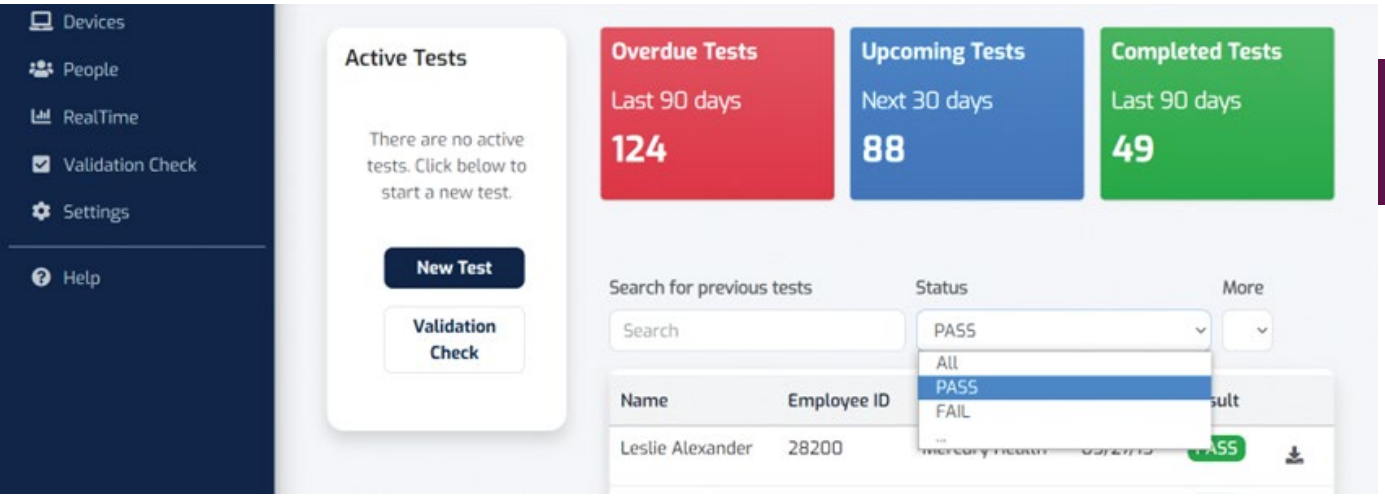
Over time, most IH instruments evolved into systems, including software to capture and graph the exposure profiles; document regulatory compliance metrics; and analyze how engineering and/or administrative controls could be implemented in place of PPE for high-exposure operations.

Yet not all measurement instruments used by industrial hygienists exist for personal exposure assessments or area measurement of toxic or explosive gases and dusts. A good example is found in the management of a respiratory protection program (RPP) and the instruments that perform fit testing for OSHA compliance to ensure the respirator issued to your employee is the correct size and model—and is proven to be effective and protective.

OSHA still allows the manual labor-intensive, subjective qualitative method to be used. Qualitative fit-testing relies on the person administering the test to observe subjects' response, as well as write down that the test was performed at a certain date, time and place. The result is only "pass or fail" with no data to support the result. Sounds an awful lot like the early days of industrial hygiene, right?

When performing quantitative fit testing of tight-fitting respirators, whether SCBA, full- or half-facepiece elastomeric, or an N95 or similar single-use filtering facepiece, fit test


**Early fit-testing programs only documented exposure and compliance, but they're capable of performing deeper analysis today.** *© littlewolf1989 - stock.adobe.com*




Use of advanced software programs for respiratory protection program management adds value for program improvement initiatives. *(photo courtesy Accutec)*

instruments make the determination of pass/fail status of the worker and their assigned respirator, based on the "fit factor."

This is why many EH&S professionals came to rely on quantitative fit test devices for an objective pass/fail assessment—automatically recorded on the machine. But the machine is in fact an instrument—performing real-time measurements using sound, scientific measurement principles.

## Factoring in Fit Factor

The fit factor is a direct measurement of seal leakage (when using the constant negative pressure [CNP] or method), or it's a ratio of the actual number of respirable particles in the ambient environment compared to the number of particles that are sampled inside the respirator while being worn (called the condensation particle counting method).

Both methods are approved by OSHA and utilize physical exercise protocols compliant with CFR 1910.134, although it should be noted that only the CPC method is able to test N95 and other types of filtering facepiece respirators in use around the world (e.g., FFP series respirators).

## Program Management Evolution

We know software is playing a far greater role today in IH program management. A good example is in hearing conservation—where exposure assessment data and medical surveillance data (i.e., audiograms) are being integrated more than ever.

Early programs only documented exposure and compliance, but they're more capable of performing deeper analysis today. Many provide management-level data aggregation for identification of at-risk cohort groups and allow comparison of effectiveness of controls and proper use of different types of PPE at sites performing similar operations.

Some go so far as to interface directly with master EH&S database systems that are either proprietary to the employer's IT infrastructure or get stored on one of the many available vendor-hosted EH&S Enterprise platforms. As a result, HCPs are becoming much more effective.

## Advanced Software Advantages

RPPs and HCPs are quite similar at the program level, both with medical screening info, known exposure to hazards and PPE effectiveness being interdependent elements that should be monitored and documented. Thus, it seems logical that using advanced software programs for RPP management is desirable and adds value for program improvement initiatives.

Yet, in this writer's opinion, this aspect of respiratory program management has been overlooked and is ready for some real advances. It could be that, since fit testing often is only performed once a year, less thought is given to how the records are kept and how they are utilized. But, if we dig a little deeper into how software could be the cornerstone of an effective RPP, it uncovers many areas for improvement.

It's safe to say that no major advances have been made in software as an effective recordkeeping and management tool since quantitative fit test instruments came into being. Cosmetic improvements were made over the years but without real gains in utility and functionality—especially where better maintenance and continuity of records is concerned.

All too often, fit test records are kept compartmentalized—stored away on individual PCs or USB sticks that get lost or fail—or get printed and kept in a file cabinet…somewhere. Often, employees leave, and "things happen."

A well-architected approach to the software environment could be taken that will propel best practice in respiratory protection into the modern era. New developments just over the horizon will pull fit test recordkeeping and individual data together in much the same way as has been done in other areas of industrial hygiene—and innovative suppliers will lead the way. Advances could include how fit test operators obtain better guidance on how to administer the test and obtain faster access to the tools they need to do their job quickly, while still doing it properly.

With support integration at the enterprise level and flexible hosting options, respiratory program managers and EH&S directors will get much better control over how, when and why tests are performed and gain deeper insight into which models of RPE fit best. Getting actionable data for continuous program improvement will save time, as well as the health and lives of at-risk workers. The current state of RPP software options will fade in the rearview, as the coming future state truly drives best practice into realm of possibility. ■

# Intelligent Fit Test Solutions

TSI® Knowledge Beyond Measure.

Respirator fit testing is about more than compliance with standards or about "checking the box" as quickly as possible, it's about safety. Staff working in dangerous environments deserve the very best protection possible from a respirator. PortaCount™ Respirator Fit Testers deliver safety by utilizing the most effective quantitative fit testing method available to identify poor fitting masks. Industry-first features train staff how respirators should be worn to be most protective.

## YOUR GUIDE TO A BETTER FIT TEST

- **Animations for a Better Fit** - Video animations guide staff through the proper movements for each fit test exercise, better identifying respirators that fit poorly. Video animations free administrators from the need to coach staff through the fit test, ensuring consistency and allowing time to multitask for increased productivity.
- **Quantifying Results, Automating Documentation** - FitPro™ Ultra Fit Test Software automatically records test results to a database that is simple to manage and share. PortaCount™ Respirator Fit Testers assist with administrative tasks beyond the fit test, allowing you to get more accomplished with your time. Documenting your program's compliance has never been easier.
- **FitCheck™ Mode** - Utilize a real-time radial display or live graph to show how a respirator's fit changes throughout donning and adjustment. Real-time FitCheck™ Mode allows you to quickly identify the right mask and provide staff with a better understanding of how their respirator fits. Instant fit feedback reduces failed fit tests and allows you to achieve a better fit in less time.
- **Fewer Steps to a Fit Test** - Starting a fit test is easy, simply complete the "Assign Person" screen and push "Start." The instrument does the rest. A simplified interface means a more user-friendly experience and an efficient use of your time.

## REAL-TIME MEASUREMENTS, REAL-WORLD SAFETY

Provide staff with a respirator fit test they can both learn from and count on. PortaCount™ Respirator Fit Testers combine real-time and real-world measurements to advance respirator safety beyond what any other fit test can deliver.

- **Real-Time Measurements** - Real-time measurements not only allow you to quickly find the correct size mask, but also provide staff with a greater understanding of how and when their respirator best protects them.
- **Real-World Safety** - Real-world measurements evaluate respirator fit during actual movement, breathing and talking; providing an accurate reflection of how a respirator will protect staff on the job.

Choose PortaCount™ Respirator Fit Testers for respirator training and fit testing you can trust.

## SOFTWARE SOLUTION FOR BOTH FIT TEST METHODS

Although the most accurate fit testing method is with quantitative fit testers (QNFT), using data to calculate the fit factor like with PortaCount™ Respirator Fit Tester, we know some respiratory protection programs still utilize the qualitative fit test (QLFT) method.

We offer Qualitative Respirator Fit Testing (QLFT) with FitPro™ Ultra Fit Test Software that helps remove the guesswork from the fit testing process with step-by-step visual guidance on conducting a qualitative respirator fit test. If you're not doing quantitative fit testing with PortaCount™ Respirator Fit Tester, let's help ensure you're doing qualitative fit testing consistently and correctly. ■

# What are Elastomeric Respirators?

Elastomeric respirators are tight-fitting respirators that provide greater than N95-level protection and are made to be safely reused for years. You may be hearing more lately about elastomeric masks online and in the media. These types of reusable, rubber half-masks are nothing new and have been a staple piece of PPE for many workers across various industries for decades.

These reusable respirators are reliable, comfortable, cost-effective and safer than any disposable mask on the market. We've broken down everything you need to know about elastomeric respirators.

**Some elastomeric respirators, like the Comfort-Air® Series by Dentec Safety, are made for industrial use, while some, like the Comfort-Air®Nx & NxMD series, are made for healthcare workers, teachers and others.** *(photo courtesy Dentec Safety)*

Elastomeric respirators are made by dozens of manufacturers and typically use N95, N99, N100 or P100 level filters. These are the most common reusable respirators found in homes and workplaces due to the added protection vs. disposableN95s. They are also more cost-effective, compared to disposable N95s.

These respirators are commonly found in mining, auto repair, construction, agricultural, pharmaceutical and home renovation industries. Rubber half-masks like these can be bought online or in your local hardware stores, including Canadian Tire, Lowes, Home Depot and Home Hardware. (Several provinces in Canada have massive stockpiles that were bought for healthcare workers that have been locked up for future pandemics since the first wave.)

Some elastomeric respirators are made for industrial use, while others are made for healthcare workers, teachers and others that need the best protection possible from deadly viruses, wildfire smoke, environmental allergens and more.

## Facts About Elastomeric Respirators

- Hospitals have been successfully using reusable elastomeric respirators as superior alternatives to disposable Filtering Facepiece Respirator (FFR) N95s for infection control since 1996.
- Cities like Winnipeg, MB, Canada, have been using elastomeric respirators to protect firefighters, police and paramedics from Covid since March 2020.
- New York stopped buying FFR N95s for firefighters and EMS since November 2020 and upgraded everyone to elastomeric respirators instead.
- A study by the American College of Surgeons published in June 2020 shows that elastomeric respirators were so well-liked by the thousands of Health Care Workers (HCWs) that used them that, after the trial was finished, not one out of the 2,000 HCWs wanted to stop using them and go back to using disposable N95s. (See Dentec's Cooper University Hospital: A Case Study on Elastomeric Respirators for Healthcare Workers)
- The CDC recommended elastomeric respirators as disposable N95 alternative during the SARS, H1N1 and for the Covid pandemic.
- An infectious disease specialist who informed the Biden administration, "there is no doubt that the lack of the more protective face masks contributed to those grim totals," issued their own pandemic preparedness plan, which they called a "Road Map for Living with Covid." Group leader, Dr. Ezekiel Emanuel, estimated that it will cost $100 billion or more to fully prepare the nation for future variants and pandemics moving forward.

The PPE section that starts on page 57, chapter 5, highlights the experts as follows:

» The supply chain of respirator manufacturing must be considered a national and economic security priority. Where necessary, domestic manufacturing capacity for respirators must be assured to safeguard sufficient supply for healthcare and other high-risk settings, with capacity to ramp up production during respiratory emergencies such as another pandemic or surge.

» The national stockpile should be replenished with elastomeric and powered air-purifying respirators for healthcare workers, which must be deployed immediately as future surges or pandemics occur.

» Healthcare workers with direct patient care responsibilities should top the priority list for personal protective equipment. They must be provided reusable respirators such as elastomeric half-mask respirators for the remainder of the pandemic.

» Workers in higher-risk settings need access to reusable respirators, such as EMS, food processing, assembly lines, grocers and warehousing, followed by workers in moderate-risk settings including restaurants, retail and transportation.

## The Advantages of Elastomeric Respirators

- **NIOSH Certified** – Elastomeric respirators manufacturers MUST get their respirators approved by Health Canada and/or NIOSH. This eliminates the risk of fraudulent and unsafe products flooding the market and ensures high-grade protection that meets safety regulations and requirements.

## THE CASE FOR ELASTOMERIC MASKS

Image courtesy of Dentec Safety

- **Better fit for all faces –** NIOSH sizing protocols drastically underrepresent women and Asian face shapes and sizes for FFRs. Many elastomeric masks can come in two sizes to provide a better fit/seal qualities for all face shapes and sizes. And, unlike many disposable N95s, there are elastomeric masks in kid's sizes available by some manufacturers.
- **More comfortable –** Internal temperature recordings inside most elastomeric masks are 2° C cooler than wearing a disposable respirator including a surgical style mask. Say goodbye to face rash and mask acne when you switch to a reusable half-mask.
- **A sustainable solution –** Elastomeric respirators can be safely reused for years, so they can provide long-term sustainability and be stored after use for future pandemics or emergency situations.
- **Less waste –** Reusable half-masks can eliminate billions of disposable masks from littering streets, landfills, rivers, lakes and oceans. We can reduce landfill waste by millions of pounds annually; reduce incineration costs for mask disposal; and help reduce carbon emissions by moving away from mass use of disposables.
- **More cost-effective –** Reusable half-masks provide the most cost-effective respiratory protection option for the public or employers. Cost no longer becomes a barrier to proper high-grade protection.
- **Can help schools and businesses stay open safely –** The widespread use and adoption of reusable half-masks could help virtually eliminate workplace transmission and outbreaks, while ending the need for future closures and lockdowns. Providing employees with high-grade protection like elastomeric respirators can keep workers safe while working in close proximity to each other and save countless jobs.
- **Prevent future pandemics –** By putting elastomeric respirators into widespread use around the world, we can stop transmission of dangerous viruses and prevent future pandemics from occurring.
- **Source Control –** Elastomeric respirators provide better source control than surgical masks and better protection from droplets and airborne transmissions vs. surgical masks and N95s.
- **Domestic Supply Chain –** Because elastomeric respirators are made in America by manufacturers like Dentec Safety, they can take away our dependency on foreign suppliers, create more jobs for North American workers and prevent disruptions along the domestic supply chain by preventing infections—which would also help stabilize the economy and reverse the rise in inflation.
- **Reduce Counterfeit Products –** The widespread adoption of elastomeric masks can eliminate the need for importing KN95s, which the CDC says six out of 10 are counterfeit and the CBC has shown even large retailers and pharmacies have accidentally been selling counterfeit KN95s.
- **Reusable and Safer! –** Disposable N95 respirators DO NOT provide an effective seal when reused more than a handful of times. Although disposable respirators meet the OSHA requirements for respiratory protection where a half facepiece is needed, the challenge with any disposable respirator is the ability to conduct a proper fit check when entering a hazardous environment throughout the day, once a fit test has been conducted.

NIOSH-approved disposable respirators are unable to continue to provide an effective seal when reused. Consider when a worker who is fit-tested on a particular style of N95 disposable respirator then goes to work. They have to shape the respirator each time they don it to try to secure a fit.

Each time you shape the disposable respirator to fit around your nose, it reduces the integrity of the structural shape of the mask, which prevents it from providing an effective seal. The use of an elastomeric half-mask with the appropriate filters will allow the individual to conduct a fit-check every time the put on the mask. This helps ensure proper fit and protection. Two important studies were conducted to support this conclusion.

**Case Study 1:** Effectiveness of Elastomeric Half-Mask Respirators vs N95 Facepiece Respirators During Simulated Resuscitation

**Conclusion:** 36 participants that were fitted with EMHR had 0% fit failure. 28% of those fitted with an FFR had a fit failure[1].

**Case Study 2:** Failure Rates During Reuse of Disposable N95 Masks in Clinical Practice in the Emergency Department

**Conclusion:** Disposable N95 masks have significant failure rates following reuse in clinical practice. Healthcare personnel also performed poorly in assessing the integrity of the seal of their disposable respirators.[2, 3]

1 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8202994/
2 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8202994/
3 https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2777504?utm_source=twitter&utm_campaign=content-shareicons&utm_content=article_engagement&utm_medium=social&utm_term=031821#.YFJnEbgpaVg.twitter

# Are You Using the Right PAPR Filter or Cartridge?

Powered Air-Purifying Respirators (PAPR) are an all-in-one, integrated system that includes a blower, headpiece, breathing tube and a filter or cartridge. All of the components work together to provide the respiratory protection your workers need, making the whole greater than the sum of its parts.

Different work environments present different hazards, so it's important to select the right filter or cartridge for your workers. Download our e-guide to learn how to find the most suitable filter or cartridge based on the exact hazards in your work environment.

DOWNLOAD THE E-GUIDE

# Air Systems International's High-Performance Grade-D Breathing Air Filtration Systems

You know us by the distinctive orange cases seen in plants and on worksites across the world. We've been building Grade-D air filtration units for almost 40 years.

We manufacture portable / panel mounted Grade-D Air filtration units to provide breathing air to workers wearing supplied air respirators. Our off the shelf Breather Boxes® / panels provide air for 1 to 8 workers based on the model. Customized panels can provide breathing air up to 3,000 CFM for an entire plant.

## SO WHAT IS GRADE-D AIR QUALITY?

Breathing air quality standards were developed by ANSI / Compressed Gas Association (CGA) G-7.1 - 1989, and adopted by OSHA under their respiratory standard 29 CFR, 1910.134.

**Grade-D Air Quality Must Meet or Exceed the Following Requirements:**

- **Oxygen:** 19.5 %-23.5 % (20 %-22 % Canada)
- **Hydrocarbon (condensed oil):** 5 mg/m3 maximum ( < 1Mg/m3 in Canada)
- **Carbon Monoxide (CO):** 10 ppm maximum (5 ppm in Canada)
- **Carbon Dioxide (CO2):** 1000 ppm maximum (500 ppm in Canada)
- **Odor:** No noticeable tastes or smells
- **Water Content:**
  - High pressure cylinder air must have a dew point of at least -50° F (-45.6° C) at 1 atmosphere (14.7 psi).
  - Low pressure breathing air must have a dew point of at least 10° F (5.56°C) below the ambient temperature at 1 atmosphere (14.7 psi)
  - Canada: 5° C below lowest temperature, 27 ppm maximum water vapor
- **Total Volatile Hydrocarbons (Canada):** 5 ppm maximum

Air Systems' portable and fixed breathing air filtration systems meet or exceed OSHA 1910.134, Canadian Z180.1 Breathing Air Standards and British Standard BS-EN 12021:1999 "Respiratory Protective Devices" for Grade-D air.

NIOSH requires each respirator wearer be supplied with 15 cfm of Grade-D Air at the manufacturer's required pressure. All of Air Systems' filtration products are designed to flow the NIOSH maximum amount of air the respirator could supply.

**NEVER** undersize a filtration system!

**The Breather Box® and panel units work with ANY airline respirator brand!**

## HIGH-PERFORMANCE GRADE-D AIR SOLUTIONS

When connected to a portable or fixed plant air compresssor, the Breather Box® and panel units provide Grade-D breathing air and continuously monitors for Carbon Monoxide (CO). CO/O2 and Intrinsically Safe Models are available.

**Key Details:**

- Carbon Monoxide (CO) Monitor
  - CO/O2 Monitor available
  - Intrinsically safe CO or CO/O2 monitors available
- Three stage filtration (99.99 % efficient at 0.01 micron particle size)
- Filter change indicators on all filters
- Incoming air plug ½" industrial interchange
- Two automatic drains with discharge tubes


- Remote alarm receptacle
- External warning lights and alarm

**Custom Options**

- Clear viewing windows
- Explosion-Proof enclosed filtration panel
- Independent regulators
- Intrinsically safe, CSA C/USA approved, versions for hazardous locations
- Auto-Air™ Feature (fully automatic reserve air system) for IDLH Environments
- Independent regulators for workers at different distances
- Large portable systems up to 150 cfm
- Large Fixed Systems up to 3,000 CFM

Custom modifications are available to meet the most demanding requirements. Contact our Customer Service Team for details on how to meet your demanding Grade-D breathing air needs.

**Air Systems International is the Industry Standard in Grade-D Air Filtration** ■

By: **Jason Rutz**, *Contributor*

# What Is Respirator Fit Testing

## *(and Why It's Important for Your Workers)*

With the increased awareness and importance of respiratory protection, elevated with the seriousness of health risks like COVID-19, choosing the right respirator is more top-of-mind than ever.

A respiratory protective device (RPD) is an essential piece of PPE to protect workers from harmful particulates, vapors, gases and other hazards that OSHA says can lead to pulmonary injuries and illnesses, such as lung diseases and even death. But a respirator, no matter how well-made, is only as good as how it fits. Gaps or leaks between the face and the sealing surface of the respirator allow harmful particles to be inhaled by the worker; this can negate the important role of even the most highly engineered respirator.

Respiratory protection is No. 3 on OSHA's recent list of most frequently cited workplace violations, reinforcing the priority of helping to keep your workers safe, healthy and compliant by choosing the best testing method to ensure a proper respirator fit.

### What Is Fit Testing

The amount of protection a respirator will provide is heavily dependent on how well it fits. Every person's face is different and, therefore, every wearer needs to undergo an individual fit test for the specific respirator they use on the job. Fit testing acts like the final exam in a respiratory protection program, which also includes a comprehensive respirator training program; medical evaluation; and selection, use and limitations of selected RPDs.

A fit test verifies the seal between the respirator and the wearer's face, identifying gaps or leaks that put workers at risk. In the end, fit testing ensures that workers can achieve the required fit and level of protection for the respirator type they are issued for the job they are performing.

OSHA requires respirator fit testing, but the process is about more than compliance or "checking the box" as quickly as possible. It's about safety. Staff working in dangerous environments deserve the very best protection possible from their respirator. Just as important is the training element: Fit testing ensures the wearer knows how to properly don and doff the respirator and how to adjust it to achieve a proper fit, as well as ensuring the respirator is comfortable to wear.

New employees should be fit tested, as part of their onboarding process, before they begin working in hazardous conditions requiring the use of

**The PortaCount is controlled by FitPro™ Ultra Fit Test Software, which guides the fit test process, while automatically recording results to a database to document your program's compliance. The intuitive software works on touchscreen tablets and PC laptops.** *(photo courtesy TSI)*

The PortaCount® Respirator Fit Tester measures the concentration of ambient particles outside the respirator and the concentration of ambient particles inside of the respirator. *(photo courtesy TSI)*

respiratory protection. After that, OSHA requires that a fit test be completed annually for anyone required to continue to wear a tight-fitting respirator for their job, per their company's written respiratory protection program. In addition, workers should re-test if there is a change in the type of respirator used—or if the wearer experiences substantial changes to their facial features, such as weight loss/gain or cosmetic surgery.

## How Is Fit Testing Conducted?

There are two primary ways to conduct fit testing: qualitative (QLFT) and quantitative (QNFT).

Qualitative fit testing uses a challenge agent, such as Saccharin Solution Aerosol (sweet tasting); Bitrex® Solution Aerosol (bitter tasting); and the wearer's sense of taste to achieve a subjective pass or fail assessment of whether the respirator fits or not.

One method of quantitative fit testing directly measures. respirator leakage by counting ambient particles both outside and inside of the respirator to get an objective measurement of the respirator's fit. Quantitative testing provides a numerical/objective measurement of respirator fit and does not rely on a subjective response, making it the most accurate method of respirator fit testing.

There are several available methods for quantitative measurements. One innovative instrument measures the concentration of ambient particles outside the respirator and the concentration of ambient particles inside of the respirator. Those two measurements result in a ratio called a "fit factor."

The test takes measurements while the person being fit tested performs a range of movements outlined by OSHA to reflect real-world use (including bending over; moving the head from side to side; moving the head up and down; talking and jogging) and confirms that the respirator can still provide the appropriate level of protection.

Software is also available that can guide the fit test process, while automatically recording results to a database to document your program's compliance. The intuitive software works on touchscreen tablets and PC laptops.

Along with ensuring a proper fit using objective numbers rather than subjective senses, a quantitative testing tool increases the efficiency of the testing process—allowing for more tests to be completed in less time. This has the added benefit of freeing test administrators to multi-task, because the instrument is doing the work. And it can help increase the percentage of passed fit tests, due to better staff training and the early identification of respirators that fit poorly.

What's more, real-time measurements not only allow you to quickly find the correct size of mask, but also provide staff with a greater understanding of how and when their respirator best protects them to achieve the best respirator fit possible. Ultimately, these efficiencies help increase the volume of fit testing and the ability of companies to manage the data and their respirator programs efficiently.

Wider adoption and acceptance of fit testing, particularly the ambient aerosol quantitative method, is one more crucial step in helping companies achieve compliance and—most importantly—keeping employees safe and healthy while on the job. ■

## About the Author

*Jason Rutz is a Global Product Manager at TSI, a leading global supplier of measurement instrumentation and software services designed to assist safety professionals with a range of solutions for evaluating exposure and safety. For more details, visit TSI.com.*

# THANKS TO OUR SPONSORS



Industrial Hygiene in the Workplace

**A RDG Media, Inc. Publication**
P.O. Box 529
Estero, FL 33929
586-227-9344
**www.IndustrialHygienePub.com**