Respirator Fit Testing

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FIND YOUR SAFETY

MINDSET | MOTIVATION | INNOVATION

TYPES OF RESPIRATORY PROTECTION

Elastomeric Half Facepiece Respirators are reusable and have replaceable cartridges or filters. They cover the nose and mouth and provide protection against gases, vapors, or particles when equipped with the appropriate cartridge or filter.

Elastomeric Full Facepiece Respirators are reusable and have replaceable canisters, cartridges, or filters. The facepiece covers the face and eyes, which offers eye protection.

Filtering Facepiece Respirators are disposable half facepiece respirators that filter out particles such as dusts, mists, and fumes. They do NOT provide protection against gases and vapors.

△ WARNING

Powered Air-Purifying Respirators (PAPRs) have a battery-powered blower that pulls air through attached filters, canisters, or cartridges. They provide protection against gases, vapors, or particles, when equipped with the appropriate cartridge, canister, or filter. Loose-fitting PAPRs do not require fit testing and can be used with facial hair.

Supplied-Air Respirators are connected to a separate source that supplies clean compressed air through a hose. They can be lightweight and used while working for long hours in environments not immediately dangerous to life and health (IDLH).
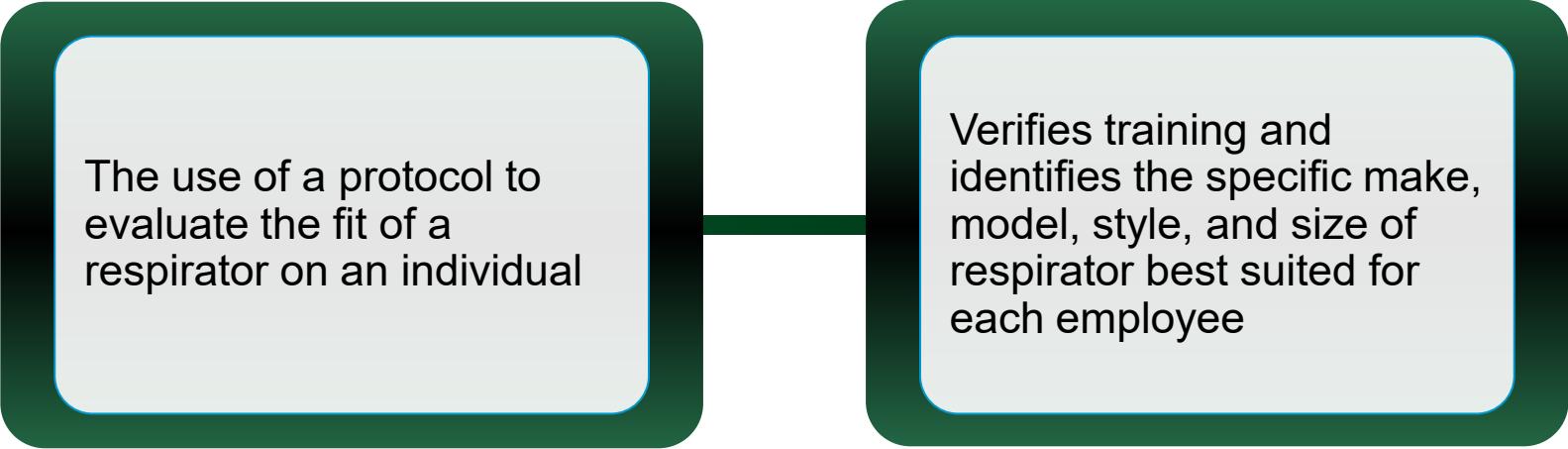
Example of an open-circuit SCBA

Self-Contained Breathing Apparatus (SCBAs) are used for entry into or escape from environments considered to be IDLH. They contain their own breathing air supply and can be either open circuit or closed circuit.

Example of an SAR/SCBA

Combination Respirators can be either a supplied-air/SCBA respirator or supplied-air/air-purifying respirator. The SCBA type has a self-contained air supply if primary airline fails and can be used in IDLH environments. The air-purifying type offers protection using both a supplied-air hose & an air-purifying component and cannot be used for entry into IDLH environments.

CDC NIOSH
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

September 2019

What is a Respirator Fit Test?

The use of a protocol to evaluate the fit of a respirator on an individual

Verifies training and identifies the specific make, model, style, and size of respirator best suited for each employee

Why Fit Test?

- Protect the health of employees
- Ensure employees are trained on their mask and their risk
- Provide employees peace of mind
- Required by:
  - OSHA 29 CFR 1910.134
  - ANSI Z88.10 – 2010
  - ISO 16975 – 2017
  - HSE INDG479
  - INRS ED 6273
  - AS/NZS 1715

Respiratory
Protection

Consistently in the top 10 citations for OSHA violations

- 2024 – 4. 2,470 violations
- 2023 – 7. 2,481 violations
- 2022 – 3. 2,527 violations
- 2021 – 2. 2,185 violations

An OSHA approved RPP requires documented:

1. Procedures for selecting respirators for use in the workplace;

2. Medical evaluations of employees required to use respirators;

3. **Fit testing procedures for tight-fitting respirators**;

4. Procedures for proper use in routine and foreseeable emergency situations;

5. Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;

6. Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;

7. Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations; and

8. Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and

9. Procedures for regularly evaluating the effectiveness of the program.

Who Can **Fit** Test?

- Competent Individual?
- Qualified Individual?
- Program Administrator?
- Anyone?

Accreditation Schemes

How About a **Repeat Test**?

When the wearer:

- Loses or gains significant weight (+/- 20lbs or 9kg)
- Undergoes any substantial dental work
- Develops any facial changes (scars, moles, etc.) around the face seal area
- At the regulated time interval (typically annually)

Qualitative Fit Testing (QLFT)

- Wearer detects leakage

- Pass/Fail Test

- Typically limited to half mask respirators

Quantitative Fit Testing (QNFT)

- Uses a machine to measure leakage

- Provides a fit factor

- Can be use on any respirator

QLFT

Subjective, Pass/Fail test that relies on the employee's response to an agent to detect leakage

- **Current typical methods:**
  - Isoamyl Acetate
  - Saccharin
  - Bitrex
  - Irritant Smoke

If the presence of the test agent is detected inside the mask, the respirator fit is inadequate

Only be used to fit test negative pressure air-purifying respirators that require a fit factor of 100 or less (typically half mask)

QLFT

- Inexpensive
- Low maintenance
- Imprecise
- Subjective
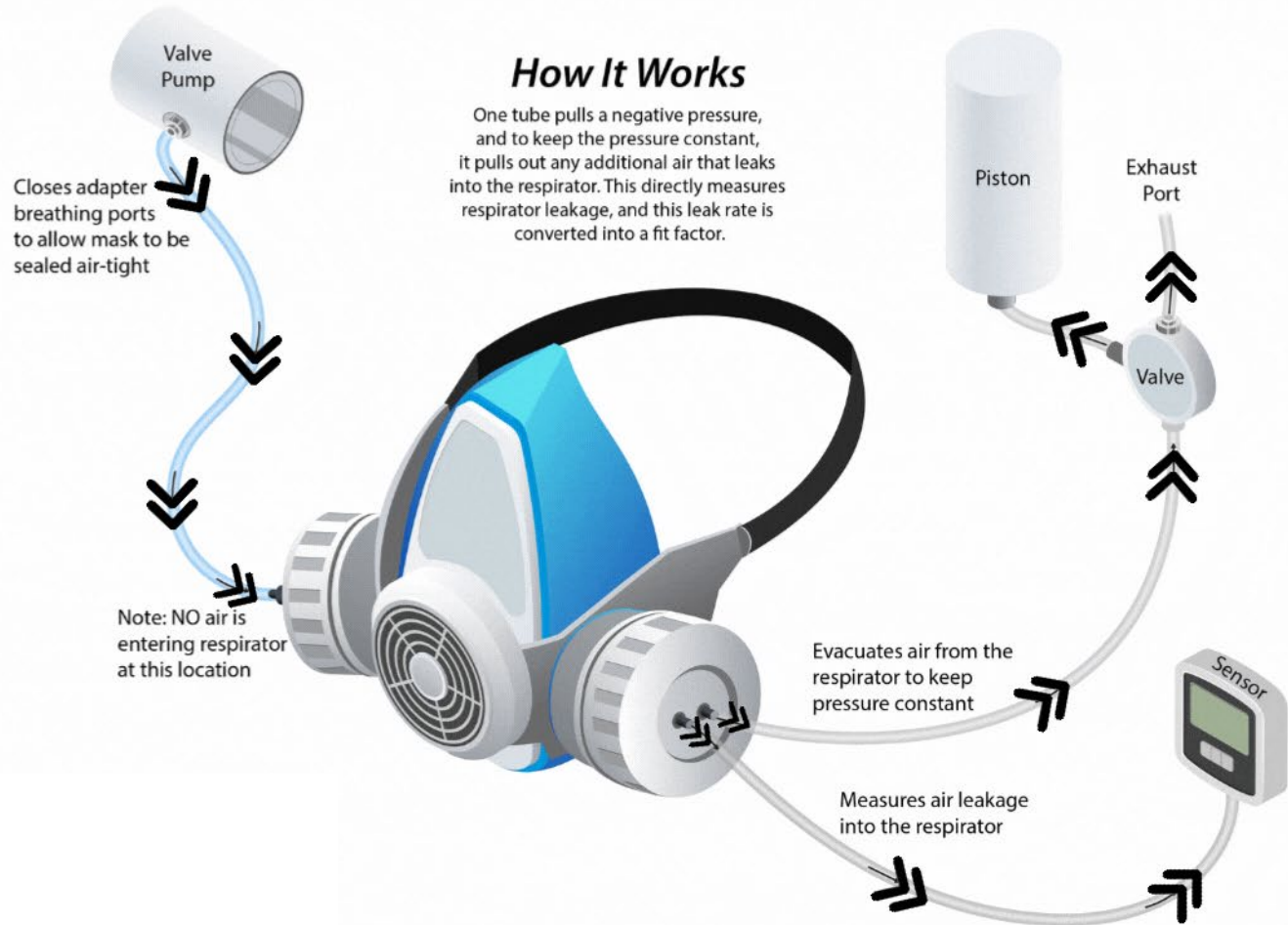- Subject to cheating
- Slow

Two Most Common Methods of QNFT:

CNP	Ambient Aerosol CNC
• OHD Quantifit & QuantiFit2 • Air is the challenge agent • Carried out by replacing filters with fit test adapters • Uses a Controlled Negative Pressure to directly measure respirator leakage	• OHD AeroFit • Aerosol is the challenge agent • Carried out by probing the respirator • Calculates the ratio of external particles to the particles in the mask

Controlled **Negative** Pressure

- Uses Controlled Negative Pressure technology directly related to a scientifically validated modelled breathing rate to measure respirator leakage.

- Respirator must be equipped with fit test adapters.

- The idea is that once a controlled pressure is achieved within the respirator facepiece, any air that is removed is the result of leakage.

- CNP precisely measures leak rate in cc/min after a series of exercises.

- The ratio of this leak rate to the modelled breathing rate is the Fit Factor.

How It Works

One tube pulls a negative pressure, and to keep the pressure constant, it pulls out any additional air that leaks into the respirator. This directly measures respirator leakage, and this leak rate is converted into a fit factor.

Valve Pump

Closes adapter breathing ports to allow mask to be sealed air-tight

Note: NO air is entering respirator at this location

Piston

Exhaust Port

Valve

Evacuates air from the respirator to keep pressure constant

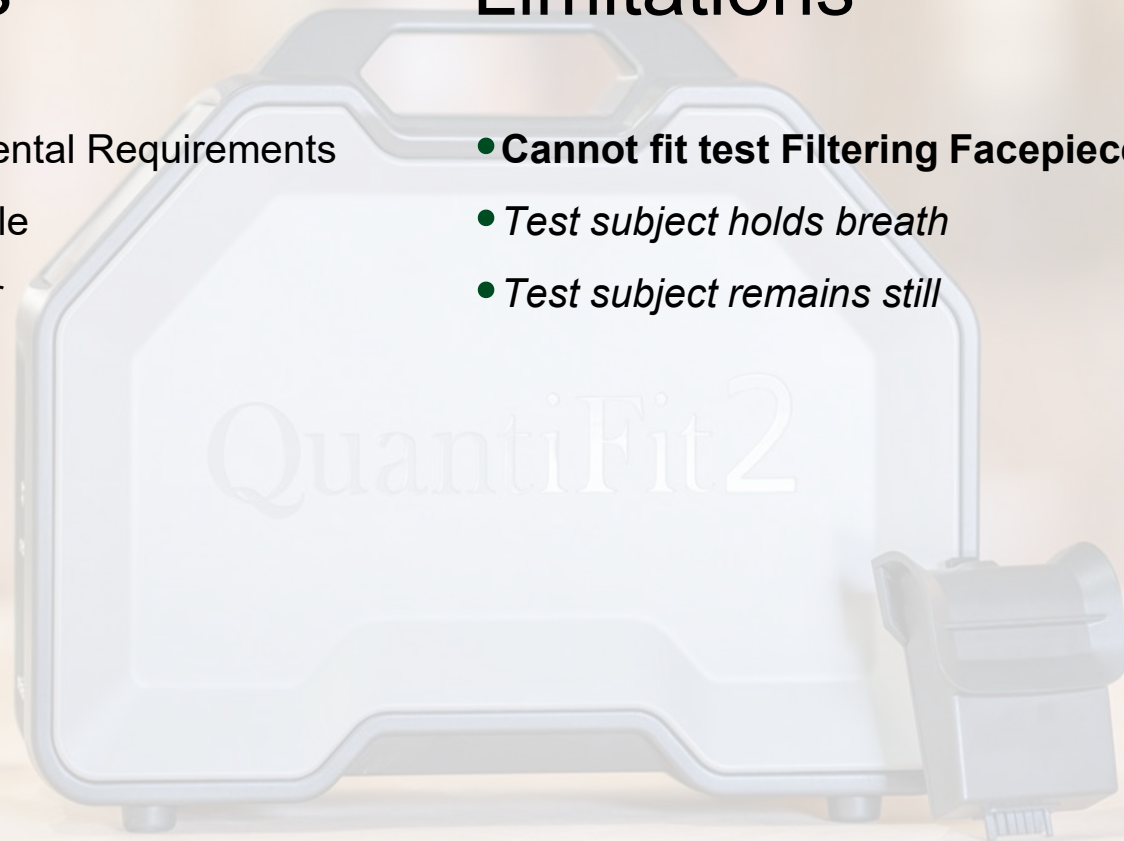Measures air leakage into the respirator

Sensor

CNP

Benefits

- No Environmental Requirements
- Highly Portable
- Battery power

Limitations

- **Cannot fit test Filtering Facepiece Respirators**
- *Test subject holds breath*
- *Test subject remains still*

CNP Redon Protocol

TABLE A–3—CNP REDON QUANTITATIVE FIT TESTING PROTOCOL

Exercises [1]	Exercise procedure	Measurement procedure
Facing Forward	Stand and breathe normally, without talking, for 30 seconds	Face forward, while holding breath for 10 seconds.
Bending Over	Bend at the waist, as if going to touch his or her toes, for 30 seconds	Face parallel to the floor, while holding breath for 10 seconds.
Head Shaking	For about three seconds, shake head back and forth vigorously several times while shouting.	Face forward, while holding breath for 10 seconds.
REDON 1	Remove the respirator mask, loosen all facepiece straps, and then redon the respirator mask.	Face forward, while holding breath for 10 seconds.
REDON 2	Remove the respirator mask, loosen all facepiece straps, and then redon the respirator mask again.	Face forward, while holding breath for 10 seconds.

[1] Exercises are listed in the order in which they are to be administered.
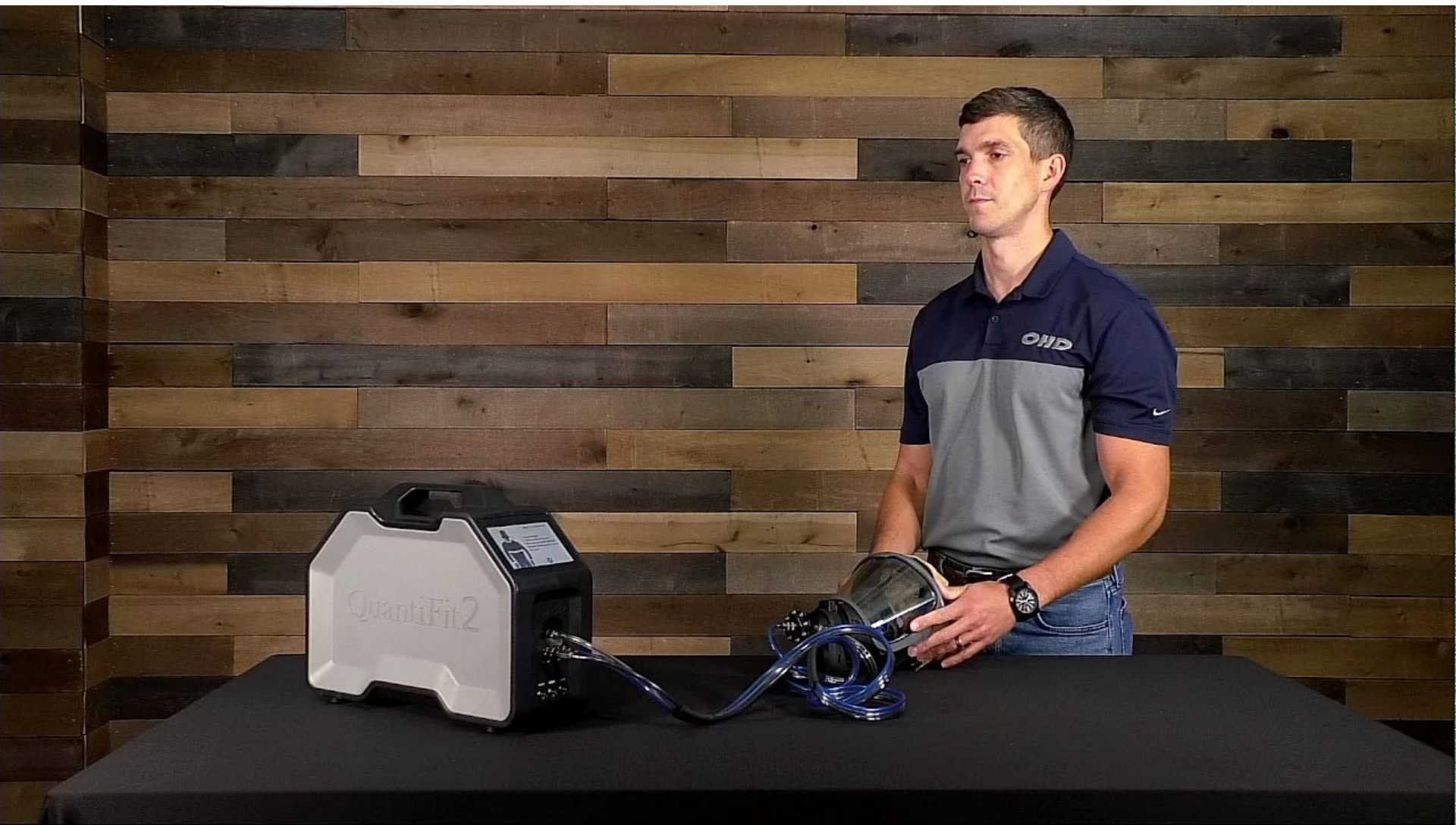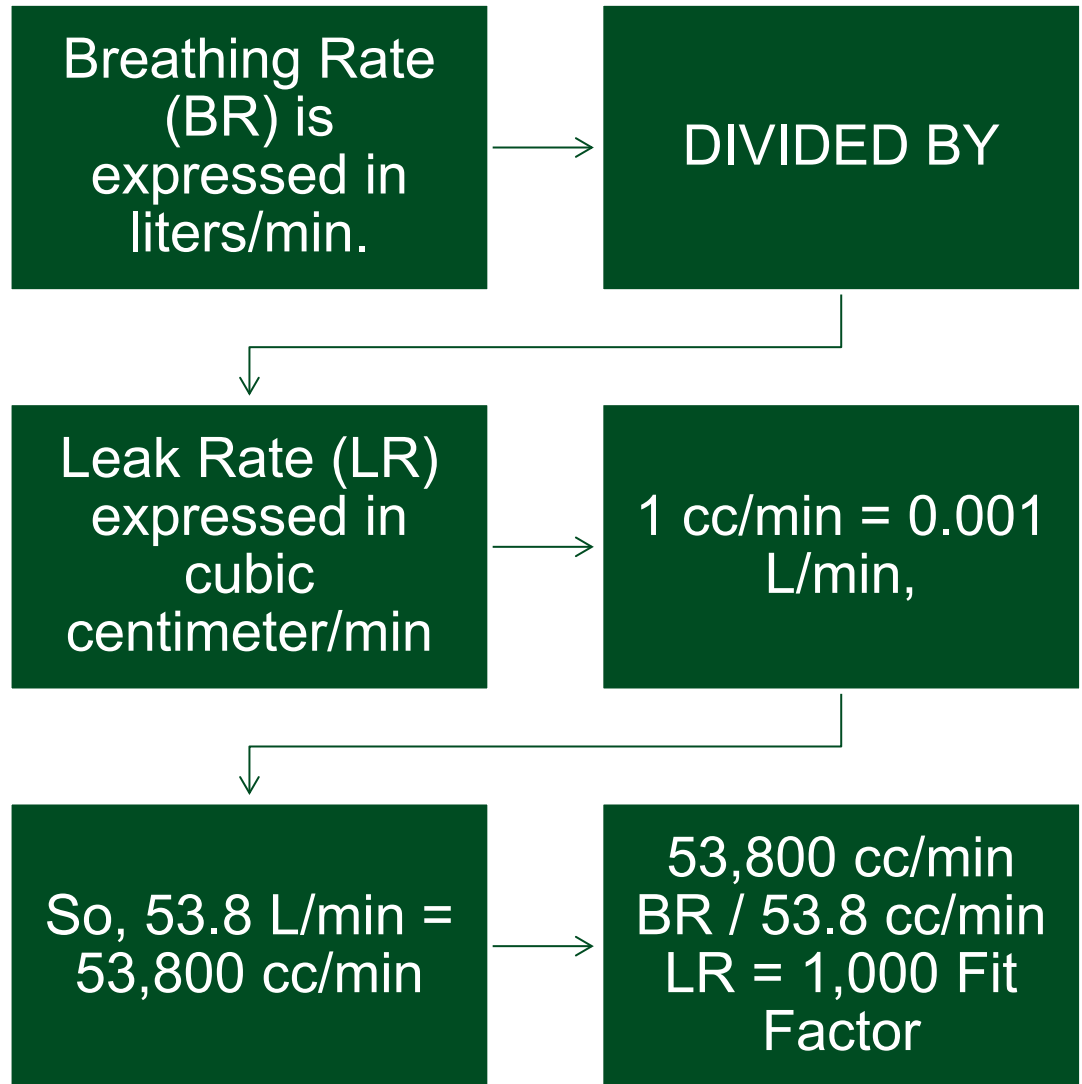
CNP Fit Factor = BR / LR

Where:

BR = inspiratory flow rate associated with CNP challenge pressure (modeled breathing rate);

LR = mean leakage flow rate (leak rate) measured with the head held still after each test exercise

CNP: Compute the Fit Factor

Breathing Rate (BR) is expressed in liters/min.

DIVIDED BY

Leak Rate (LR) expressed in cubic centimeter/min

1 cc/min = 0.001 L/min,

So, 53.8 L/min = 53,800 cc/min

53,800 cc/min BR / 53.8 cc/min LR = 1,000 Fit Factor

Condensation Nuclei Counting

- Uses laser technology to measure aerosol concentrations inside and outside the respirator.

- Respirator must be equipped with high efficiency filters.

- The idea is that because few particles penetrate a high efficiency filter, any found inside the respirator can be attributed to face seal leakage.

- Measures the concentration of particulates in the respirator while the test subject is performing a series of exercises.

- The ratio of this concentration in the breathing zone to the ambient particulate concentration is the Fit Factor.

-
-
-
-

CNC/APC

Benefits

Can fit test any tight-fitting respirator

Limitations

Environmental requirements

Consumables

Test Subject should not eat or smoke for 30 minutes before testing

CNC "Fast Fit" Protocols

TABLE A–1—MODIFIED CNC QUANTITATIVE FIT TESTING PROTOCOL FOR FULL FACEPIECE AND HALF-MASK ELASTOMERIC RESPIRATORS
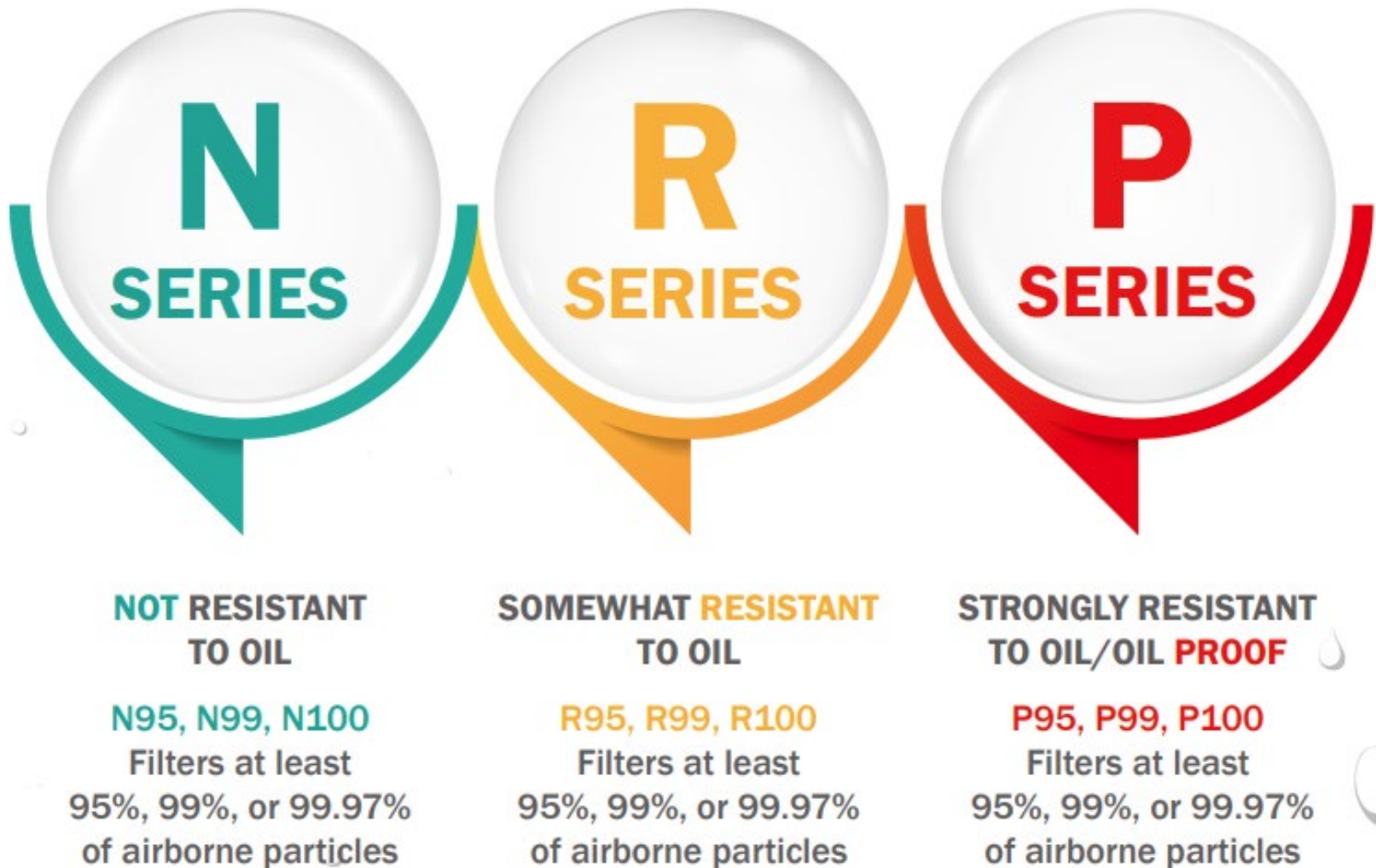
Exercises [1]	Exercise procedure	Measurement procedure
Bending Over	The test subject shall bend at the waist, as if going to touch his/her toes for 50 seconds and inhale 2 times at the bottom [2].	A 20 second ambient sample, followed by a 30 second mask sample.
Jogging-in Place	The test subject shall jog in place comfortably for 30 seconds	A 30 second mask sample.
Head Side-to-Side	The test subject shall stand in place, slowly turning his/her head from side to side for 30 seconds and inhale 2 times at each extreme [2].	A 30 second mask sample.
Head Up-and-Down	The test subject shall stand in place, slowly moving his/her head up and down for 39 seconds and inhale 2 times at each extreme [2].	A 30 second mask sample followed by a 9 second ambient sample.

[1] Exercises are listed in the order in which they are to be administered.
[2] It is optional for test subjects to take additional breaths at other times during this exercise.
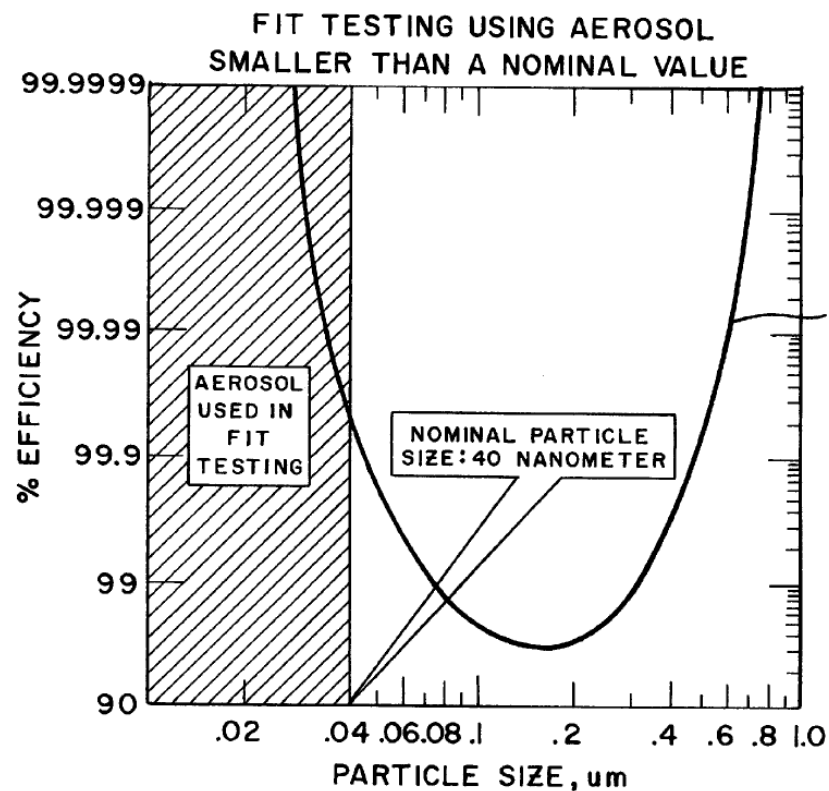
TABLE A–2—MODIFIED CNC QUANTITATIVE FIT TESTING PROTOCOL FOR FILTERING FACEPIECE RESPIRATORS

Exercises [1]	Exercise procedure	Measurement procedure
Bending Over	The test subject shall bend at the waist, as if going to touch his/her toes for 50 seconds and inhale 2 times at the bottom.[2]	A 20 second ambient sample, followed by a 30 second mask sample.
Talking	The test subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor for 30 seconds. He/she will either read from a prepared text such as the Rainbow Passage, count backward from 100, or recite a memorized poem or song.	A 30 second mask sample.
Head Side-to-Side	The test subject shall stand in place, slowly turning his/her head from side to side for 30 seconds and inhale 2 times at each extreme.[2]	A 30 second mask sample.
Head Up-and-Down	The test subject shall stand in place, slowly moving his/her head up and down for 39 seconds and inhale 2 times at each extreme.[2]	A 30 second mask sample followed by a 9 second ambient sample.

N SERIES

NOT RESISTANT TO OIL

N95, N99, N100
Filters at least 95%, 99%, or 99.97% of airborne particles

R SERIES

SOMEWHAT RESISTANT TO OIL

R95, R99, R100
Filters at least 95%, 99%, or 99.97% of airborne particles

P SERIES

STRONGLY RESISTANT TO OIL/OIL PROOF

P95, P99, P100
Filters at least 95%, 99%, or 99.97% of airborne particles

N95/DMA Explanation

MINIMUM FILTER EFFICIENCY	N SERIES	P SERIES	R SERIES
	Not resistant to oil	Somewhat resistant to oil	Strongly resistant to oil
95%	N95	P95	R100
99%	N99	P99	R100
100% (99.97%)	N100	P100	R100

FIT TESTING USING AEROSOL SMALLER THAN A NOMINAL VALUE

AEROSOL USED IN FIT TESTING

NOMINAL PARTICLE SIZE: 40 NANOMETER

% EFFICIENCY

PARTICLE SIZE, um

CNC Fit Test

CNC
Fit Factor
=
C_{out} / C_{in}

Where:

C_{out} = number concentration of particles in an aerosol sample outside of the respirator in the surrounding ambient air;

C_{in} = number concentration of particles in an aerosol sample inside the respirator

CNC: Compute the Fit Factor

Concentration of ambient aerosol found outside of the respirator expressed as a count

DIVIDED BY

Concentration of aerosol found in inside the respirator expressed as a count

6000/6

= 1,000 Fit Factor

Overall Fit Factor =
N / [1/FF1 + 1/FF2+… 1/FFN]

Where:

N = The number of exercises;

FF1 = The fit factor for the first exercise;

FF2 = The fit factor of the second exercise;

FFN = The fit factor of the Nth Exercise.

Harmonic Mean

- A kind of average
- It is appropriate for situations when the average of rates is desired
- Tends strongly toward the lowest rates of the list
- Lessens the impact of large outliers
- Worsens the impact of small outliers

Overall fit factor example

- FF = 1000, 500, 750, 1250, 1500
- Formula = N / [1/FF1 + 1/FF2+… 1/FFN]

- 5/[(1/1000)+(1/500)+(1/750)+(1/1250)+(1/1500)]

- Overall fit factor = 862

Fit testing for the public?

A fit test can really help engage a person in their own protection

Clinics for low-cost fit testing of a respirator

Occupational Health Clinics could open to the public

Concerns:

- Medical clearance
- Liability
- Abuse

FY24 Goal: How can we identify innovative solutions to assess and validate fit of a wide variety of respiratory protective devices and improve adoption by end users?

NIOSH is participating in standards development activities for Respirator Fit Capability (RFC-ASTM)

The Respirator Fit Evaluation Crowdsourcing Challenge asks innovators to develop tools to provide wearers immediate feedback about FFR fit
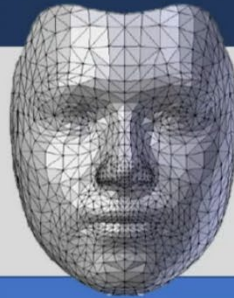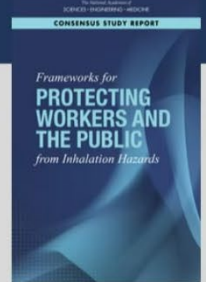
The Mobile Facial Scanning App will provide the wearer immediate feedback about the likelihood a specific FFR will fit

The Train-the-Trainer Fit Test Framework will improve access to fit testing for workers without RPPs and the Public
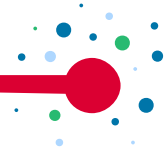
NPPTL's established DEIAB relationships and efforts are key to long-term health equity success for underserved PPE users

Coordinating strategy and outreach to incorporate research and conformity assessment relevant to the public

Breathe Easy

With the launch of AeroFit, OHD is the only respirator fit testing manufacturer with _both_ CNC and CNP technologies.

OHD

YOUR PROTECTION. OUR PRIORITY.

Q&A

Thank you!
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