

## Respiratory Protection Then, Now, and in the Future

Pennsylvania Governors Occupational Safety and  
Health Conference  
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### National Personal Protective Technology Laboratory

**VISION:** Our vision is to be the leading provider of quality, relevant, and timely personal protective technology research, training, and evaluation.

**MISSION:** The mission of the Personal Protective Technology Program and the National Personal Protection Technology Laboratory is to prevent work-related injury, illness and death by advancing the state of knowledge and application of personal protective technologies.




Photos Courtesy of 3M and MSA





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### Quality Partnerships Enhance Worker Safety and Health

Visit us at: <http://www.cdc.gov/niosh/npptl>

Disclaimer: The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of a company or product name does not constitute endorsement by NIOSH.




Photos courtesy of Aepin and Draeger





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### In the beginning ...



MSA Gibbs Breathing Apparatus Respirator

Photo courtesy of MSA



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### Milestones in Respiratory Protection

- 1910 - The U.S. Bureau of Mines (U.S. BOM) was established
- 1919 – The U.S. BOM produced Schedule 13, “Procedures for Establishing a list of Permissible Self-Contained Mine Rescue Breathing Apparatus”
- 1920 – MSA Safety Company manufactured the first respirator, approved by the U.S. BOM, for industrial use. This was the Gibbs breathing apparatus respirator.



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### Milestones

- 1930s – The Hawk’s Nest Tunnel Disaster expedited Schedule 21’s standards for filter-type dust/fume/mist respirators
- 1965 – Schedule 21B was expanded to provide additional regulation and protection for industrial workers
- 1969 – the Federal Coal Mine Health and Safety Act resulted in regulations governing the certification and use of approved respirators in the mining industry



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### Milestones

- 1970 – Occupational Safety and Health Act
  - National Institute for Occupational Safety and Health – regulatory
  - Occupational Safety and Health Administration – enforcement
- 1970 – Respirator Approval Authority Transferred to NIOSH
- 1972 – All Respirator Approvals were Integrated into a Single Rule
  - 30 CFR 11 replaced 30 CFR 14
- 1972 – U.S. BOM and NIOSH signed an interagency agreement, defining their roles, and transferring applications and testing to NIOSH



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### Milestones

- 1973 - 30 CFR 11 official changed regulations transferring testing and applications from U.S. BOM to NIOSH
- 1995 – 42 CFR 84 replaced 30 CFR 11
- 1995 – Dust, fume, and mist replaced with particulate in the rule
- 1995 – Criteria and designations for filter types established
  - N, P, and R



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### Milestones

- 2001 - National Personal Protective Technology Laboratory established in Pittsburgh
- 2001 - Respirator standards for use by emergency responders against the range of potential CBRN threats initiated
- 2002 – June 3, 2002 – NIOSH issued first approval for CBRN SCBA



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### Where we are now...



Photos courtesy of CleanSpace, Moldex, and MSA

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### What Types of Respirator Provide Protection from CBRN?

- Self-contained Breathing Apparatus
- Air-Purifying Respirators
- Powered Air-Purifying Respirators
- Escape Respirators



Photo courtesy Shutterstock

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### Why is CBRN Protection Different?

	General Working Population	First Responders	Military
Purpose	Product Certification Minimum design, performance, quality	Product Certification Enhanced design, performance, quality	Product Procurement Performance specs/operational requirement
User Group	General worker population – wide fitness levels and age	Wide age emergency responders – better physical fitness	Physically conditioned military personnel – younger age group
Hazard	Toxic industrial chemicals, O <sub>2</sub> Deficiency, Fire	Bio, chemical, rad & warfare agents in extreme conditions	Chemical warfare agents under battlefield scenarios
Operation	Hazard characterized w/engineering & admin. controls	Hazards unknown, Uncharacterized, uncontrolled	Hazard characterized, escape paths, dissipate with time & weathering
Protection	40 hours/week, 30 years with no adverse health effects	Multiple short term engagement w/mild non-persistent effects	Limited missions Limited casualties & incapacitations

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## How to Find CBRN-Approved Respirators

- NIOSH NPPTL website Certified Equipment List

Respirators Providing CBRN Protection

Manufacturer

Type  
 Self-Contained Breathing Apparatus (SCBA)  
 Air-Purifying Respirator (APR)  
 Air-Purifying Escape Respirator (APER)  
 Powered Air-Purifying Respirator (PAPR)

Order the results by:  
 Approval Number  
 Manufacturer Name

[View Results](#) [Reset](#)




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## How Many are Currently NIOSH-Approved?

- 296 – Self-Contained Breathing Apparatus offering CBRN protection
- 24 – Air-Purifying Respirators offering CBRN protection
- 38 – Air-Purifying Escape Respirators offering CBRN protection
- 13 – Powered Air-Purifying Respirators offering CBRN protection



Photo courtesy of MSA




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## What's Approved ... By the Numbers

- N95 Filtering Facepiece Respirators – 429 approvals BUT a lot more products available. Many approvals have multiple “brands” (private labels). What does that mean?
- How can I tell?

NIOSH	Company	Phone Number
*A	Private label of Louis M. Garrison Company, Inc. US	800-225-8623
*AA	Private label of Foss Manufacturing Company	603-929-6000
*AB	Private label of Valmy SAS of France (2013) US	1-450-844-3946
*AC	Private label of Jiangsu Chang Hong Industrial Manufacturing Factory LLC of China (2015) US	86-519-8691-8080
*AD	Private label of Souths Serial Protective Product Manufacturing Company, Ltd US	86-512-66100068
*AE	Private label of Souths Emergency Industries Co., Ltd. US	+86 512 65860278 / 65262618




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### Back to the Numbers ...

- 21 N99 Filtering Facepiece Respirators (FFRs)
- 7 NI100 FFRs
- 29 P99 FFRs
- 9 P100 FFRs
- 30 R95 FFRs

You can find all of the makes and models of filtering facepiece respirators on the NIOSH NPPTL website in a table, with the donning instructions.




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### More Numbers

- 570 - Air-Supplied Non CBRN
- 6 - Closed-Circuit Escape Respirators
- 79 - Air-Purifying Respirators – think Gasmask
- 256 - Supplied-Air Respirators
- 320 – Air-Purifying Respirators, including PAPRs
- 1,724 – Air-Purifying Respirators

You can find all of these approvals on the NIOSH NPPTL website in the Certified Equipment List




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Where we are going...  
What we are looking at ...




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## Combination Unit Respirators

- 2015 – The Institute of Medicine convened a workshop Developing a Performance Standard for Combination Unit Respirators
  - What is a Combination Unit Respirator?
    - A multi-functional respirator that employs the technology of two or more types of respiratory protective devices that generally differ in assigned protection factors
  - What types of respirators can be part of a combination unit respirator?
    - Open circuit self-contained breathing apparatus (SCBA)
    - Closed circuit self-contained breathing apparatus
    - Supplied-Air Respirator (SAR)
    - Powered Air-Purifying Respirator (PAPR)
    - Air-Purifying Respirator (APR)

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## Why a combination unit? Users -

### PROs

- Ability to switch between modes without doffing the respirator
- Used by some law enforcement and military units
  - Ability to quietly approach situation
- Some industrial use
- Benefit of a single mask with modular design

### CONS

- Additional weight

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## Why a combination unit? Manufacturers -

- Standard needs to be performance based, not design based
- Industrial use – entry and exit from high-risk work environments such as spraying highly toxic paints on fighter jets, and asbestos stripping industries
- Need the ability to separately certify the various modules or combinations for flexibility
- Concern over heat and weight

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### Combination Unit Respirators – where are we now?

- NFPA 1987 Standard on Combination Unit Respirator Systems for Tactical and Technical Operation
- Currently in the “proposed” category
- Public Input Closing Date January 9, 2020
- **Have something to contribute or comment?**  
– [www.nfpa.org](http://www.nfpa.org)

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### Future respiratory protection needs for special populations - Improving comfort, performance and fit

#### What are special populations?

- Women
- Increased Ethnic Diversity
- Aging Workforce
- More Disabled Workers
- Non-traditional occupations using Respiratory Protection  
– Healthcare workers

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### Ethnic Diversity, Women ...

- Different Facial Shapes
  - Los Alamos National Lab fit test panel developed late 1960s based on facial measurements of U.S. Air Force personnel
    - › Young, fit, primarily Caucasian
  - NIOSH created anthropometric database to developed two new fit test panels
    - › Based on 10 facial dimensions
    - › Bivariate panel covers 96.7% U.S. male respirator users and 98.7% U.S. female respirator wearers

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### Aging Workforce Concerns

- Reduced respiratory function
  - Wearing respirator creates additional burden
- Changes in facial features
  - Thinner or wider face
  - Loss of skin flexibility and firmness
- Hearing loss
  - Wearing a PAPR or SCBA, can they hear?
- Reduced visual acuity
  - Full facepiece or canisters / cartridges interfere?



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### Addressing the Aging Workforce

- Need to push 'special populations' higher up the agenda
- Need better fitting and greater size range of facepieces
- Need to develop products with lower breathing resistance



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### Addressing the Special Populations' Needs

Drivers	Need	Manufacturers	Standards	Regulation
• Aging skin and loss of flexibility and firmness	• Greater fit capability	• Better fitting and/or increased size ranges	• Total Inward Leakage plus Fit capability requirements	Mandatory frequent fit testing
• Reduced lung function	• Lower breathing resistance	• Advances in filtration materials & techniques	• Lower breathing resistance limits	Greater respiratory protective equipment compliance enforcement
• Musculoskeletal Disorders	• Lighter products	• Advances in materials & design for improved ergonomics	• Objective - practical performance assessment	
• Comfort	• Increased comfort	• Advances in materials & design • Improved fit • Lower weight • Better balance • Lower heat burden	• Objective - practical performance assessment • Fit capability • Simulated wear performance testing • Reduced CO <sub>2</sub> limits	
• Reduced visual acuity	• Improved integration with corrective eyewear	• Advances in design	• Objective - practical performance assessment	
• Reduced cognitive functions	• Simple to use • 'Maintenance free'	• Advances in materials & design	• Objective - practical performance assessment	
• Other PPE	• Better integration with other PPE	• Modular and integrated PPE	• PPE ensemble requirements	
• Loss of hearing	• Improved communications	• Integrated speech transmission /communications	• Improved speech intelligence performance requirements and testing	
• Special wearer – healthcare, pharmaceuticals etc.	• Bio agents • Easy to decontaminate	• Advances in materials & design	• Objective - practical performance assessment • Better alignment of performance standards	

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### Addressing the Special Populations' Needs

- Powered-Air Purifying Respirators for Healthcare
  - NIOSH research project, partnered with manufacturers, academia, and other researches to design a new generation of PAPR specifically for healthcare
  - › Support, not interfere with healthcare workers tasks
  - › Comfortable and tolerable
  - › Support healthcare system policies and practices



Photo courtesy of Ballard



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### Options or alternatives to What is Used Now

- Using elastomeric half-mask respirators in hospitals in lieu of FFRs
  - Tremendous shift in culture
  - Project currently underway at 3 healthcare facilities
- Using PAPRs in healthcare systems
  - More expensive to purchase
  - No fit test needed for loose-fitting models
  - Could save \$\$



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### Options or Alternatives

- FFR that “sticks” on. No straps. No fit testing. One size fits all.
  - Submitted for approval. Did not pass NIOSH testing.
  - In theory it worked ... but in testing it failed and those that tried it didn't like it. Hurt their face. Left welts.




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### Addressing Other Issues

- Fit testing
  - Looking at imbedded sensor in elastomeric half mask that would use surface acoustic waves to continuously measure particles inside and outside the facepiece. This technology would eliminate the need for annual fit testing for elastomeric half masks.
- Shortages of Filtering Facepiece Respirators During Pandemic or other Public Health Emergency
  - Stockpiles – shelf life issues
  - Can production be increased quickly




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### Addressing Other Issues

- Respiratory Protection for Wildland Firefighters
  - A standard exists for a respirator specifically for this population
  - No product on the market because there is no demand by the WFF




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## What are the Needs or Desires in YOUR Industry?

- What would you like to see?
- What changes to the respiratory protection program?
- What questions do you have?
- What information do you need?



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## Where to go for Information?

[www.cdc.gov/niosh/npptl](http://www.cdc.gov/niosh/npptl)

For all things respirator

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## Thank you

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