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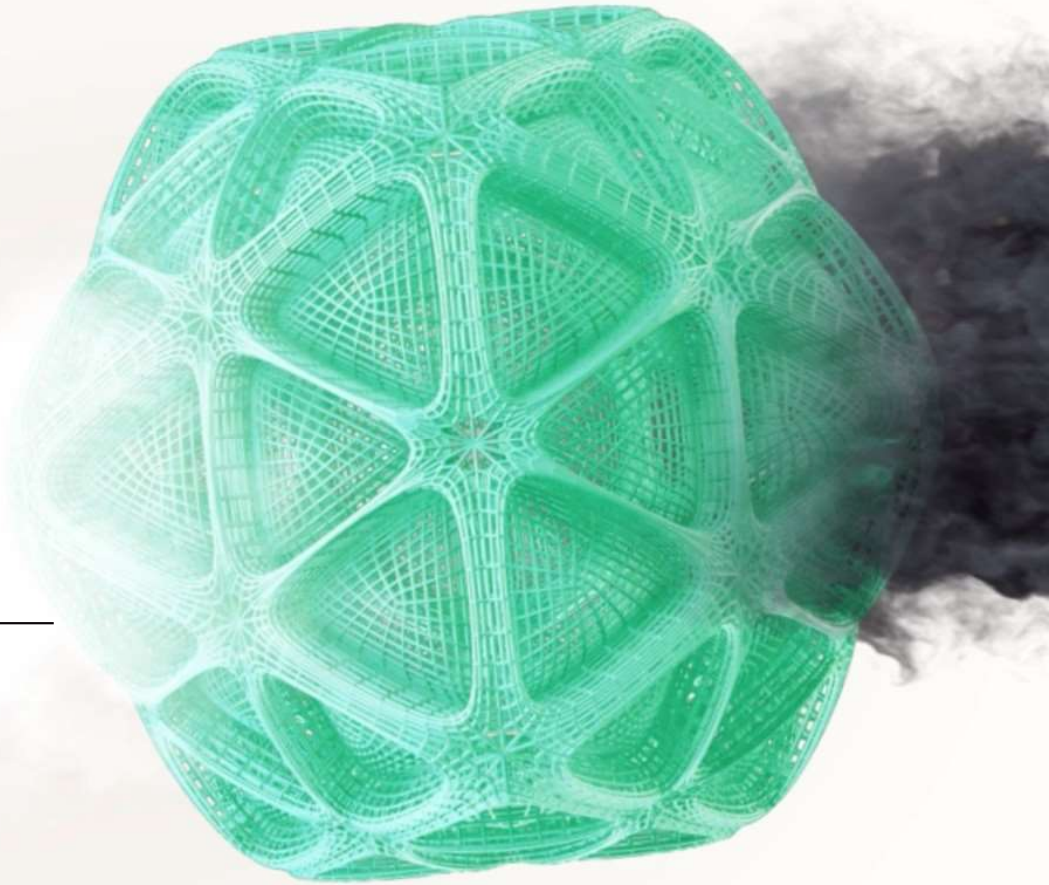
SEAL Gas Air Purification using Metal-Organic Frameworks



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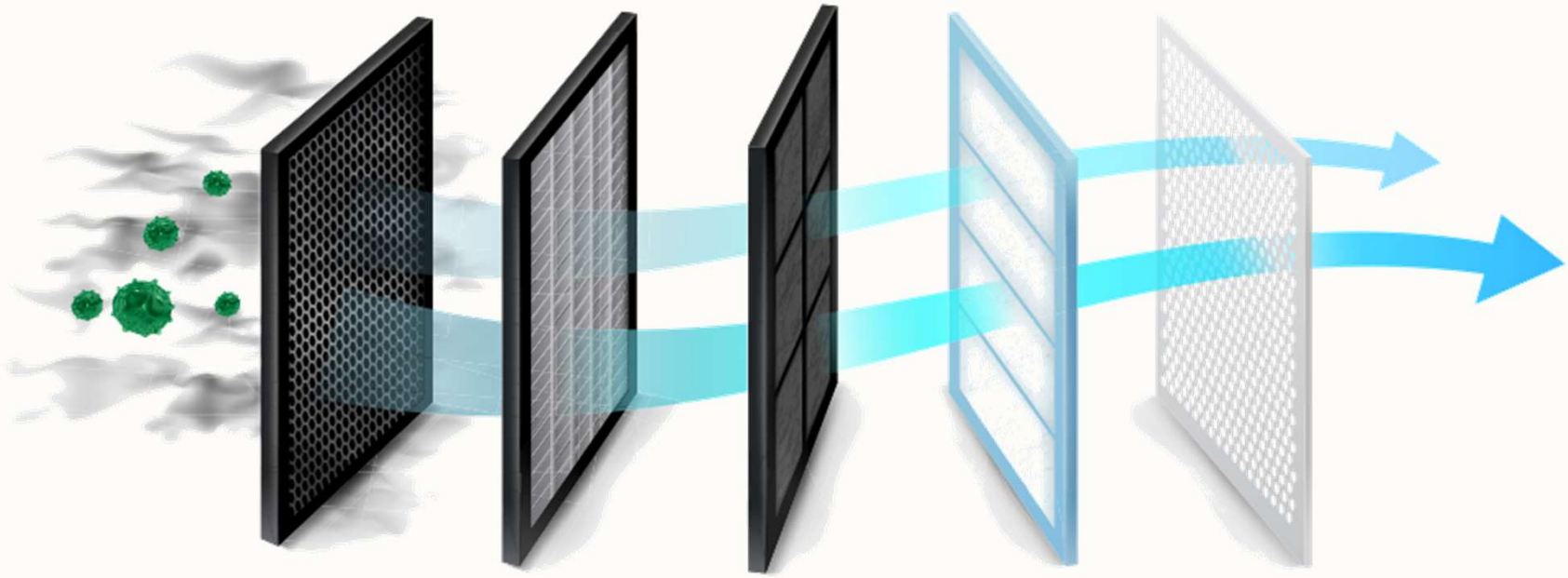
Bottom Line Up Front

- In DISSUB, SEAL gases gradually render the air toxic. This shortens the rescue window.
- MOFs are premium sorbents for removing SEAL gases from air.
- Numat has developed MOF-based SEAL Gas Scrubber concepts for extending DISSUB survivability.
- Numat seeks community input to guide product design selection.

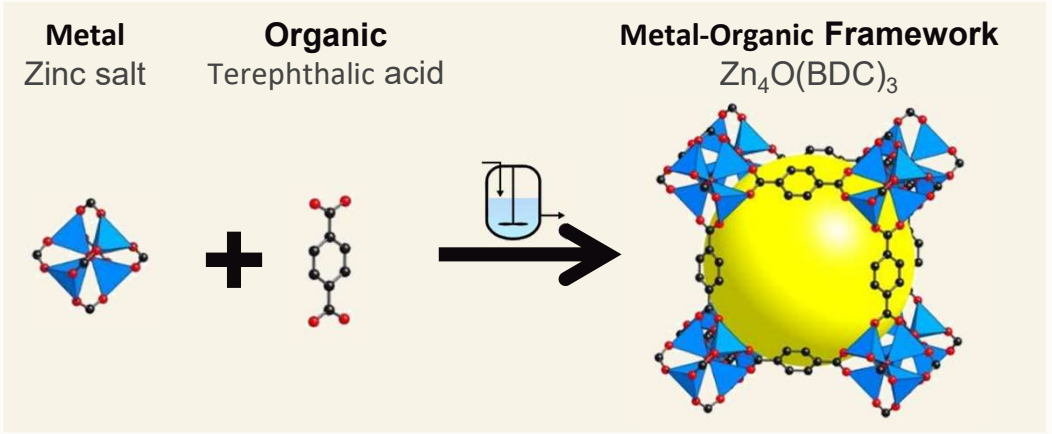
What are sorbents?

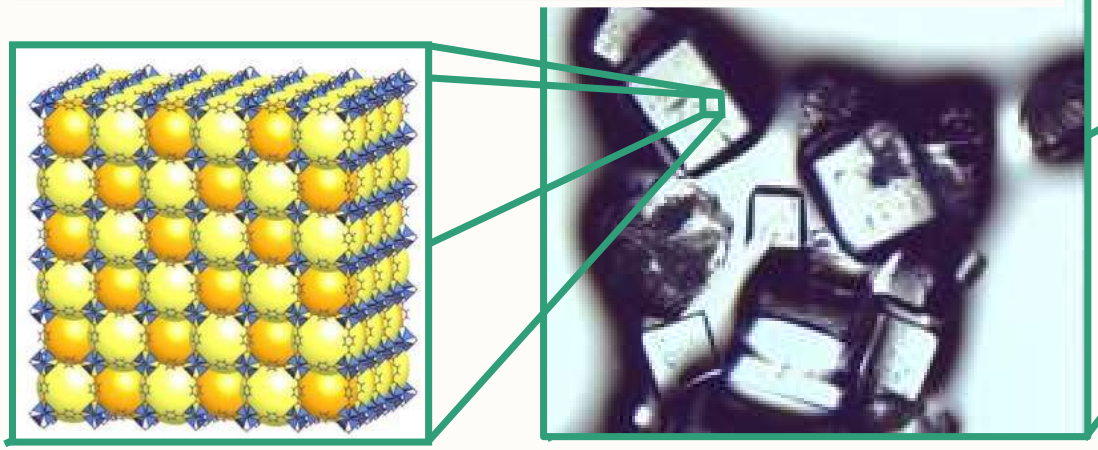
Sorbents are porous materials used for filtering toxic chemicals out of air



What are MOFs?

MOFs are high-performing sorbents made my mixing **metal** and **organic** reagents

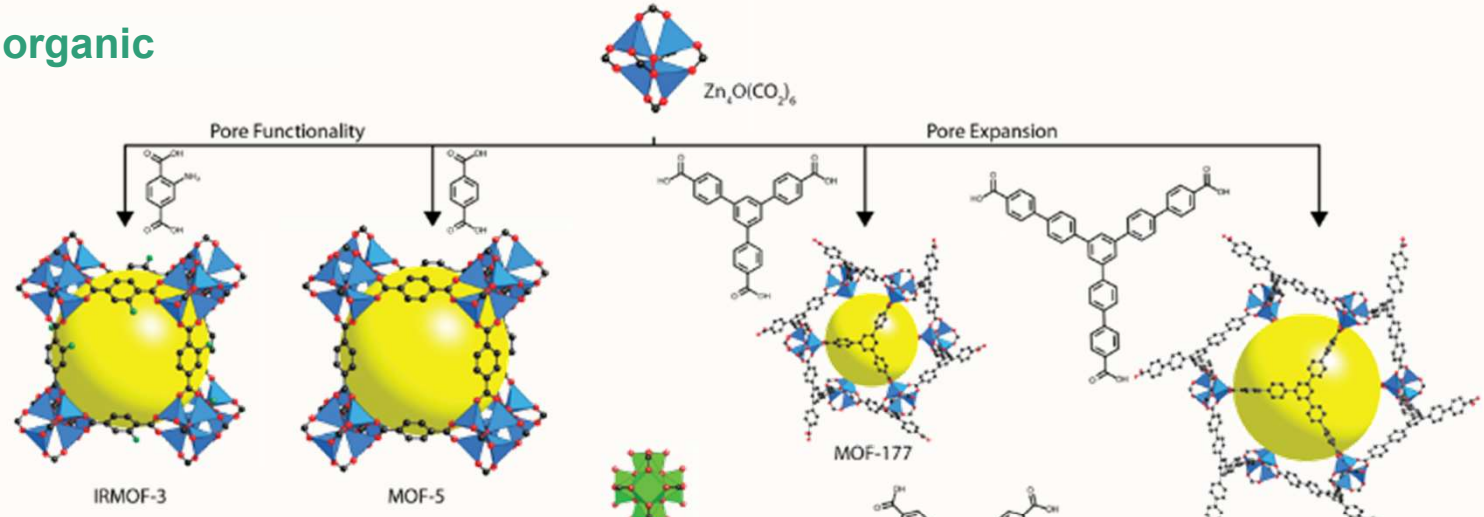




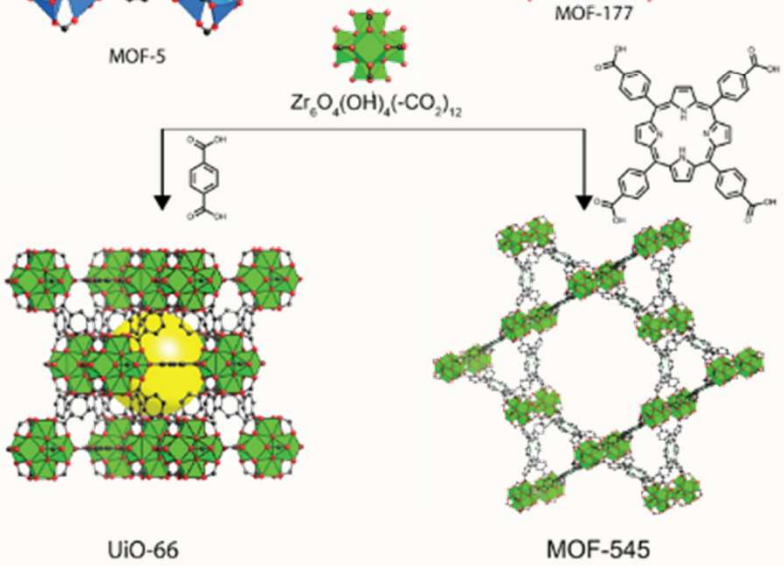
What are MOFs?

MOFs are designed by selecting the appropriate metal and organic reagents

Changing the **organic**

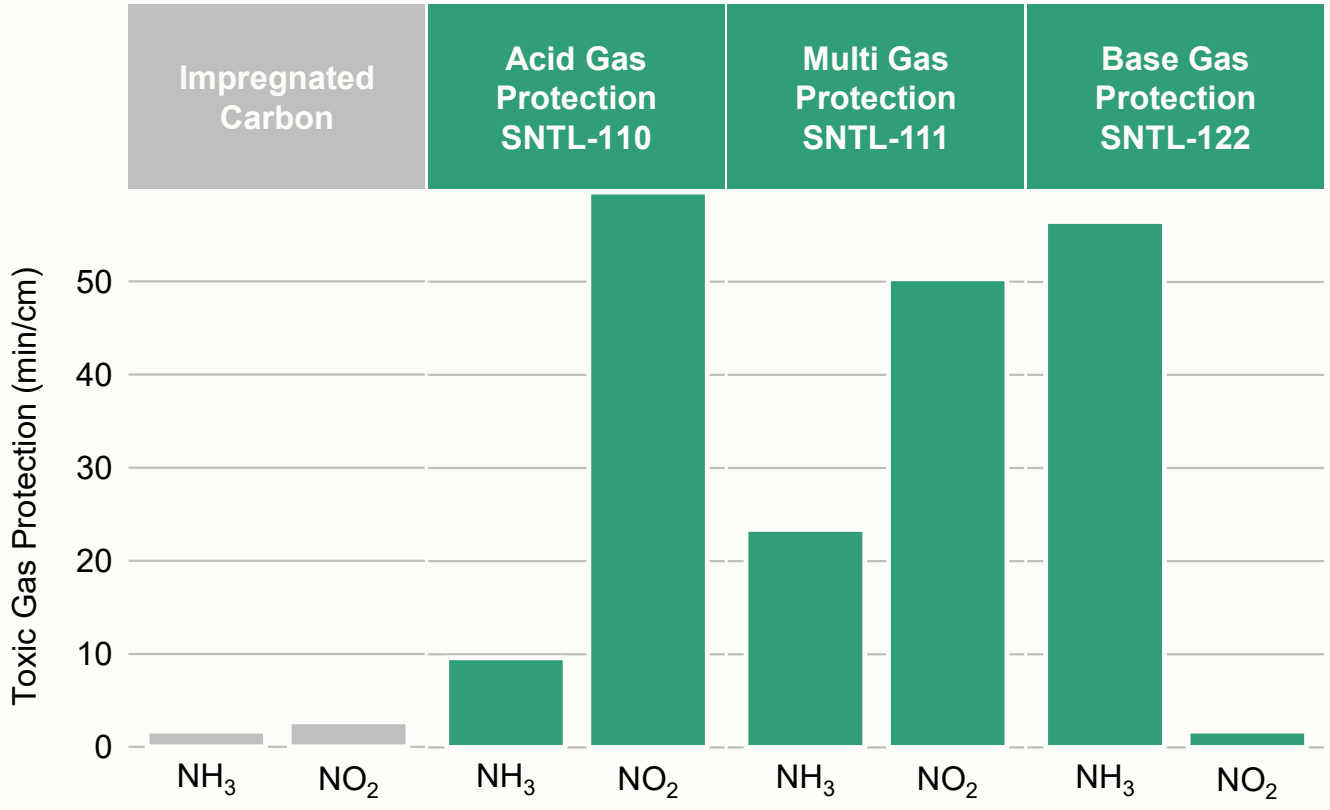


Changing the **metal**



How well do MOFs perform?

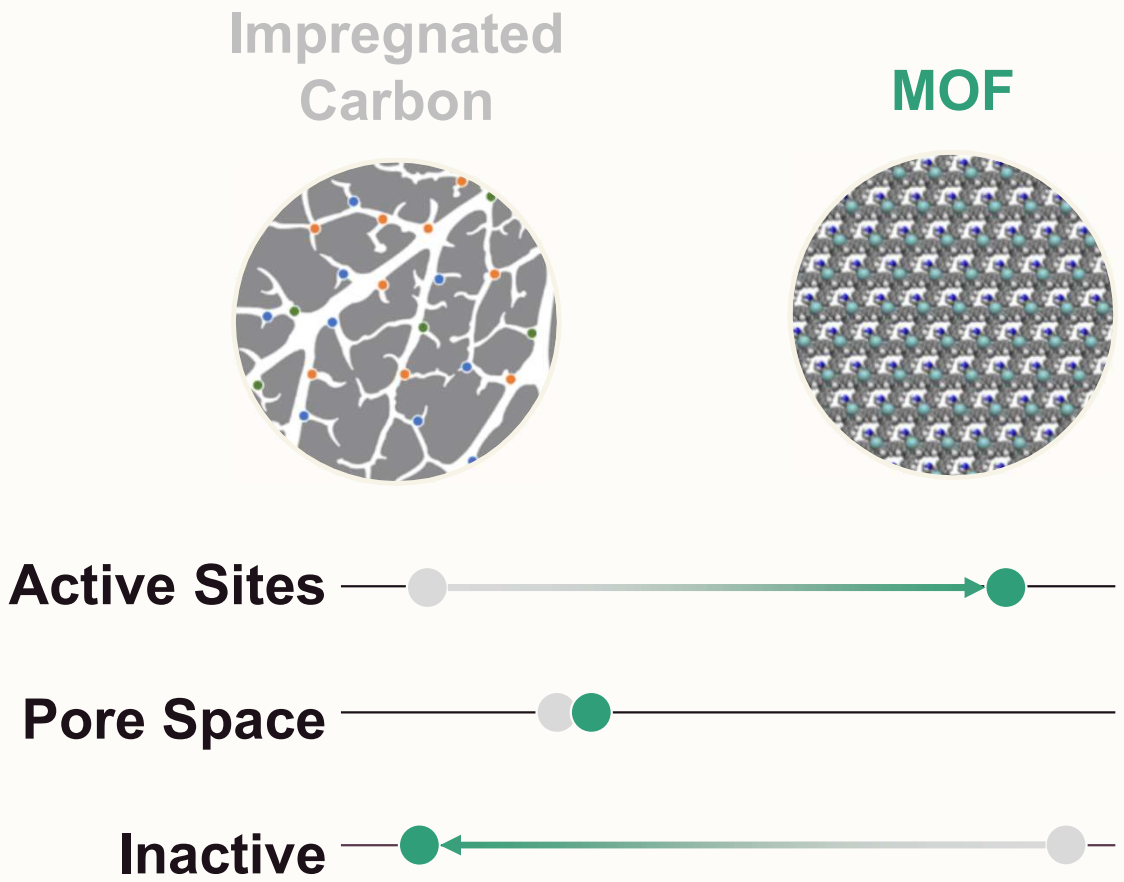
A well-designed MOF performs 5-20x better than other sorbents*



*NIOSH CBRN APR, see appendix slide for test details

Why do MOFs perform so well?

Most sorbents waste as much as 80% of their space; a well-designed MOF does not



Use MOFs when performance matters

Benefits

Extreme performance

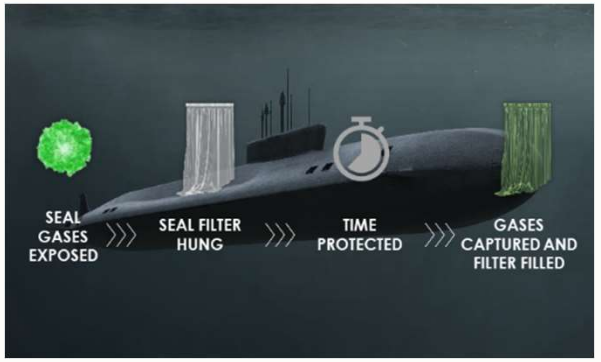
Drawbacks

Limited supply

Higher cost

DISSUB Air Purification

- DISSUB survival relies on maintaining a breathable atmosphere long enough to mount a successful rescue.
- Toxic gases such as NH_3, NO_2, and CO gradually build up, limiting air breathability even with an oxygen source.
- Under Topic N211-034, Numat and US NAVSEA have developed SEAL Gas Scrubber prototypes.

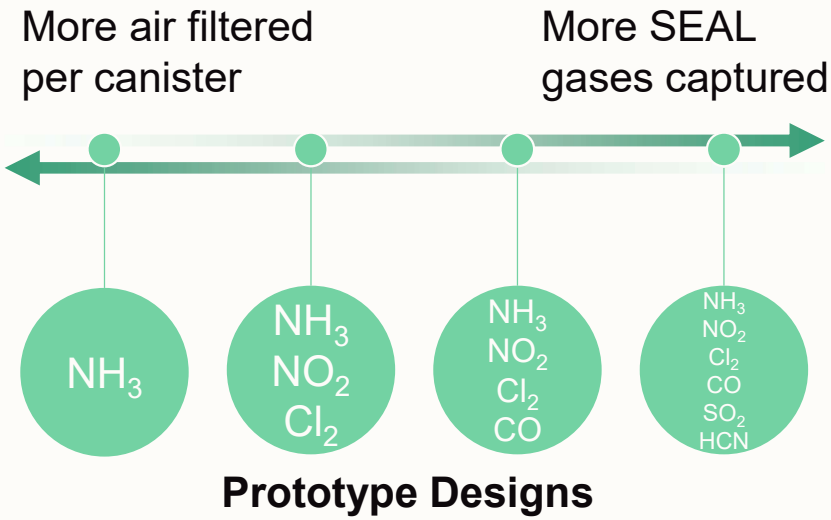


Product Status: Developing Test Standards

- Multiple prototype designs have shown a trade space between SEAL gas breadth and capacity.

- What SEAL Gas Scrubber design best solves the problem?
  - What SEAL gases matter most for extending survival?
  - How well do existing emergency procedures and environmental factors handle each SEAL gas?

- Test standards and baselines are needed to answer these questions.



Prototype Designs

Questions?

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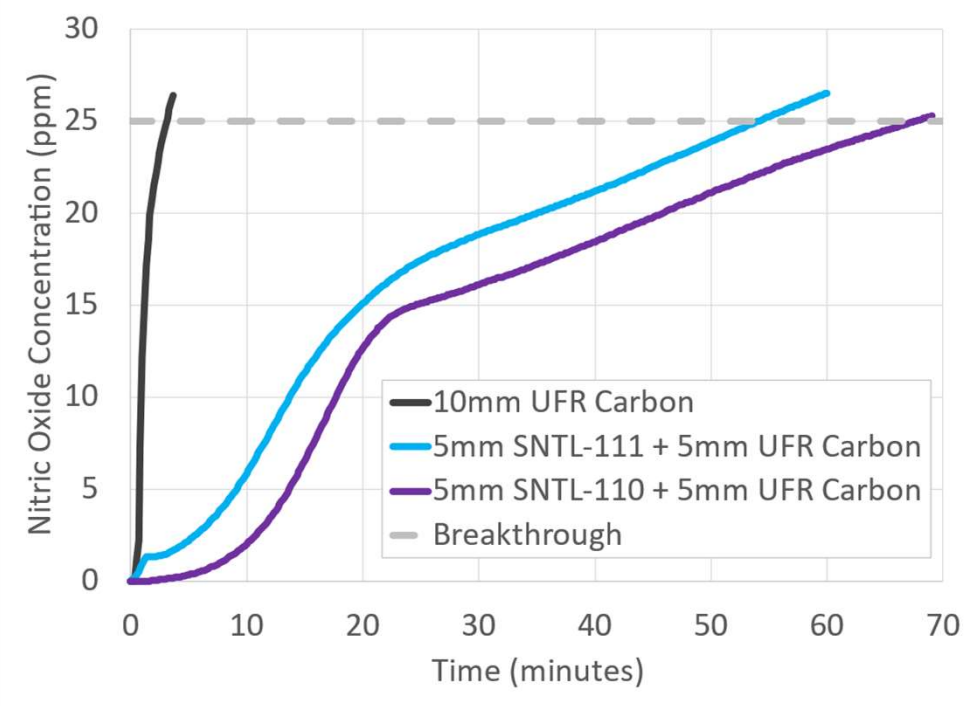
Appendix

NIOSH CBRN Air Purifying Respirator

US respiratory test standard to determine worst-case gas protection performance

Nitrogen Dioxide

12.4 cm/s, 80%RH, 25°C, 200ppm inlet



Ammonia

12.4 cm/s, 25%RH, 25°C, 2500ppm inlet