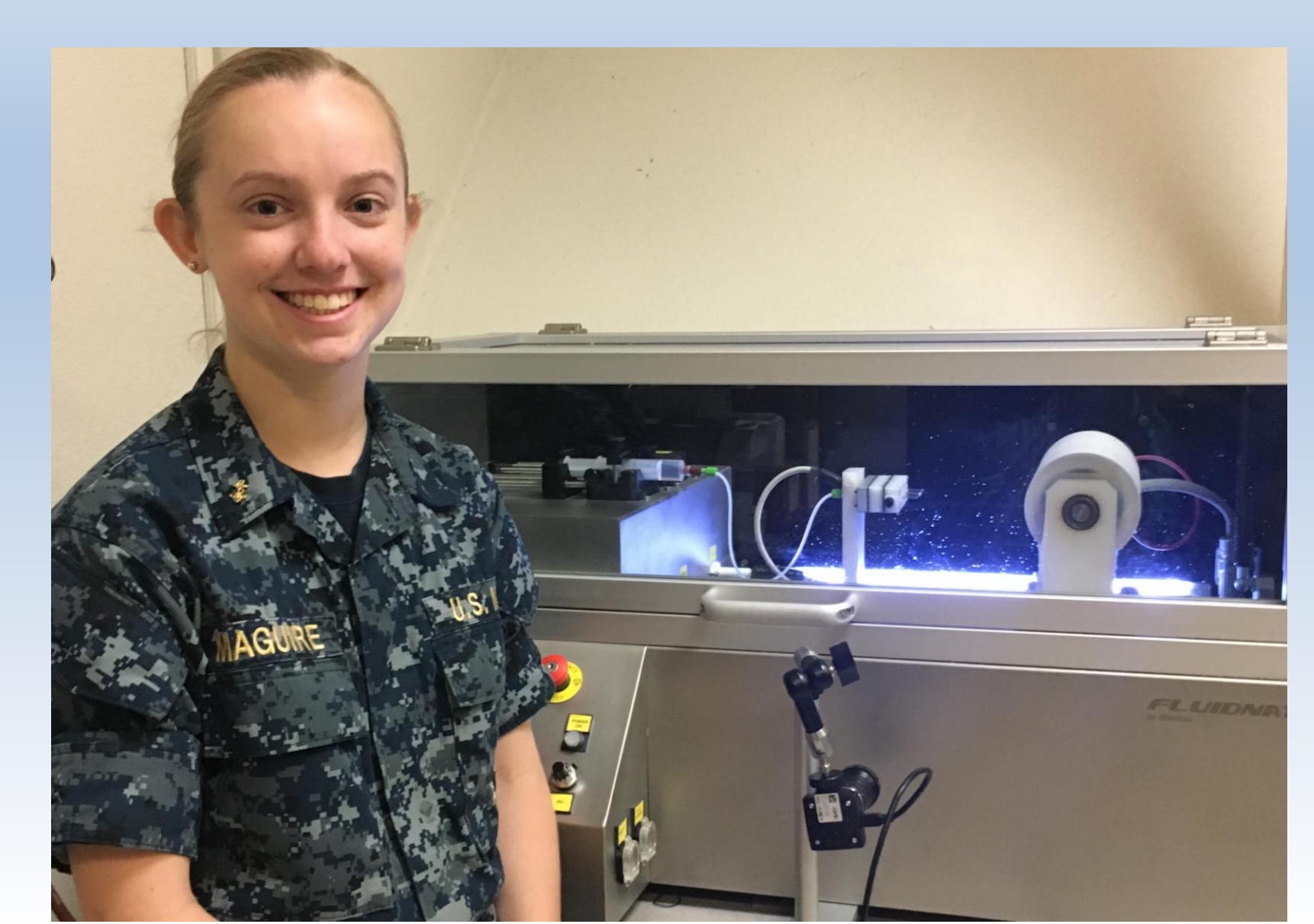


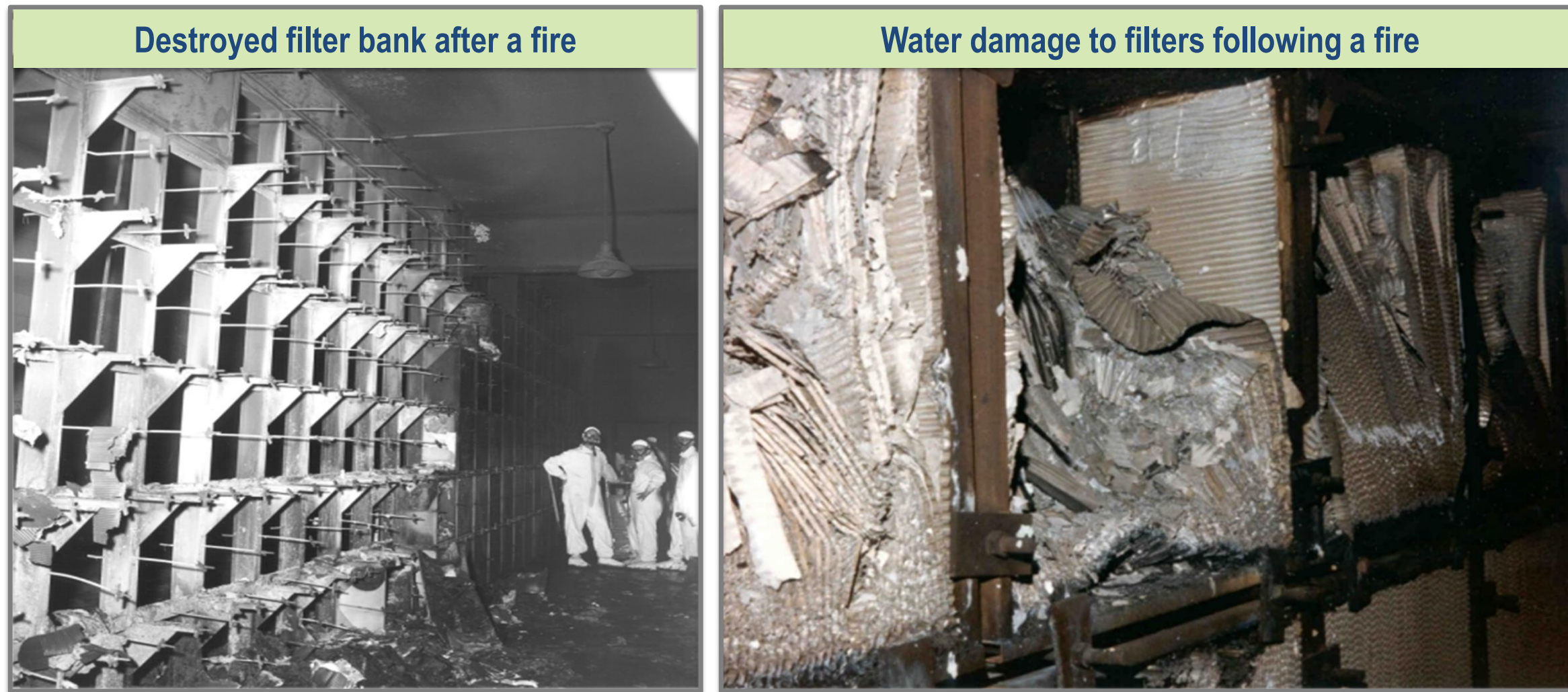
Development and Characterization of MTC Filter Prototypes

MTC filters can improve safety, reduce operational costs, and enable *in situ* monitoring

James P. Kelly, Jamie Maguire (USNA), Jeffery Haslam, Mark Mitchell

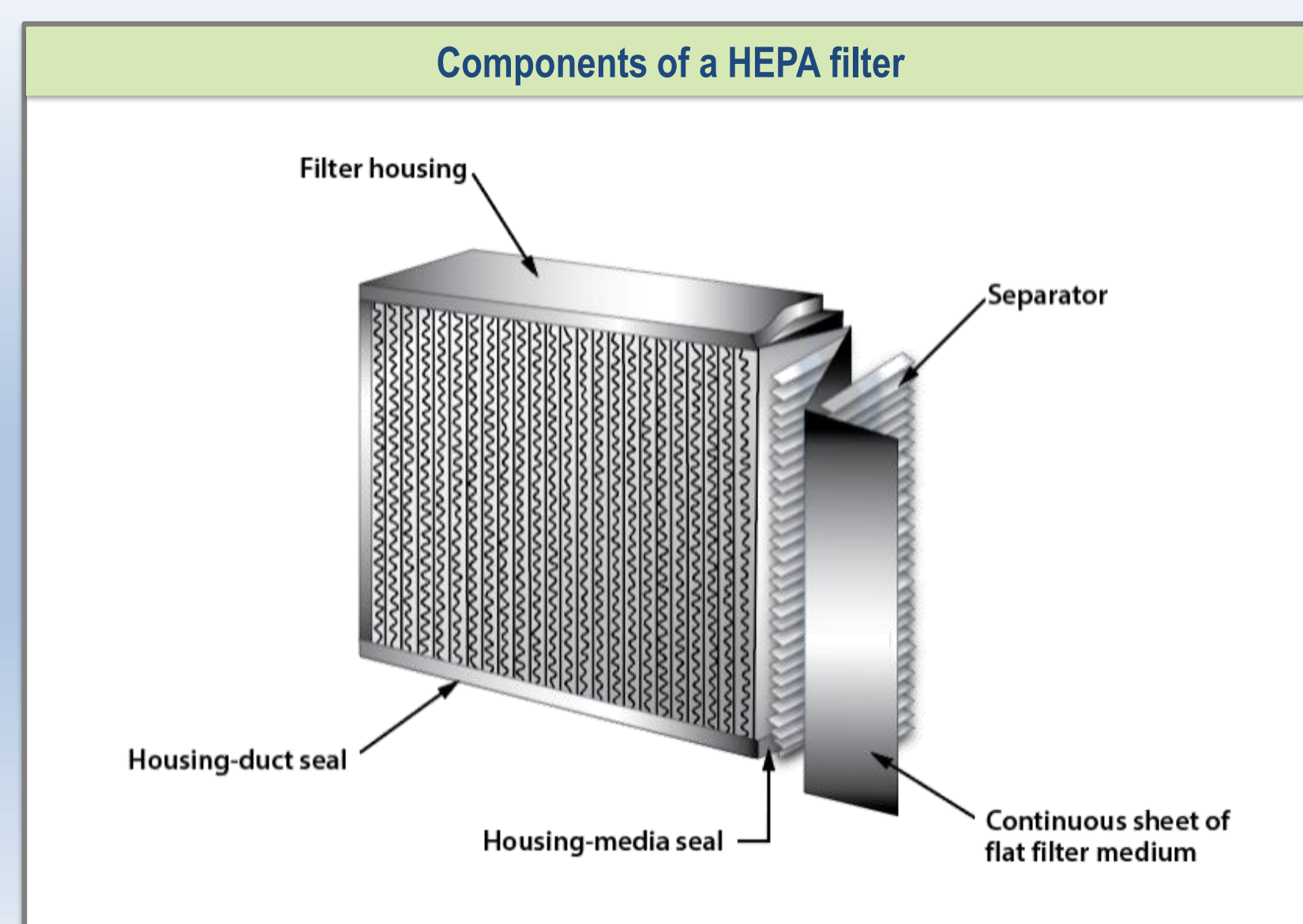


Need for Fire and Water Tolerant HEPA Filters



- Defense Nuclear Facilities Safety Board previously highlighted need for HEPA filter R&D
- Fire and water damage to filters has been a problem in the past and has, for example, resulted in expensive installation, monitoring, and maintenance of fire suppression systems to protect HEPA filters

Limits of Current HEPA Filter Technology



- Polymers in filter (binders and seals) are susceptible to thermal and water damage
- Filter media susceptible to water and corrosion
- Metal separators are susceptible to corrosion

Electrospun Filter Media

Electrospinning equipment

Fiber jet and whipping

Fiber collector

3YZ nanofibers (90 nm avg. diameter)

3YZ after 850°C exposure

- Electrospun media (polymeric) has been implemented into patented filter designs
- Pressure drop through electrospun media is an order of magnitude too high
- Implementing ceramic media is also hindered by processing challenges related to scaling up and shrinkage during thermal conversion

Acknowledgements

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Mini-Tubular Ceramic (MTC) Filter Concept

Individual Mini-Tubular Media

Membrane filtration flow path

Contact filtration flow path

Collection of Mini-Tubular Media in Flow Path

Pressure-drop and filtration-efficiency test apparatus surrogate MTC filter

MTC HEPA media surrogate test

- Fabrication of mini-tubular filter media circumvents primary process challenges (scaling and shrinkage during thermal conversion)
- A collection of MTC media in tubular containment can be implemented into existing filter designs
- Randomized orientation of the MTCs creates local pressure gradients that mix the flow stream
- Tests on a MTC proof-of-concept filter media demonstrated reduced pressure drop through the filter compared to flowing directly through a membrane

MTC Filter Media

- Fibrous sheets can be formed into more robust macro structures like miniature rings or tubes
- Self-supported geometries enable shrinkage during thermal conversion without mechanical constraint

Pre-ceramic MTC filter media

MTC filter media after thermal conversion

Pre-ceramic nanofibers

Ceramic nanofibers (1000°C treatment)

Collection of MTC filter media

Tube length (mm-scale)

Thickness/diameter (mm-scale)

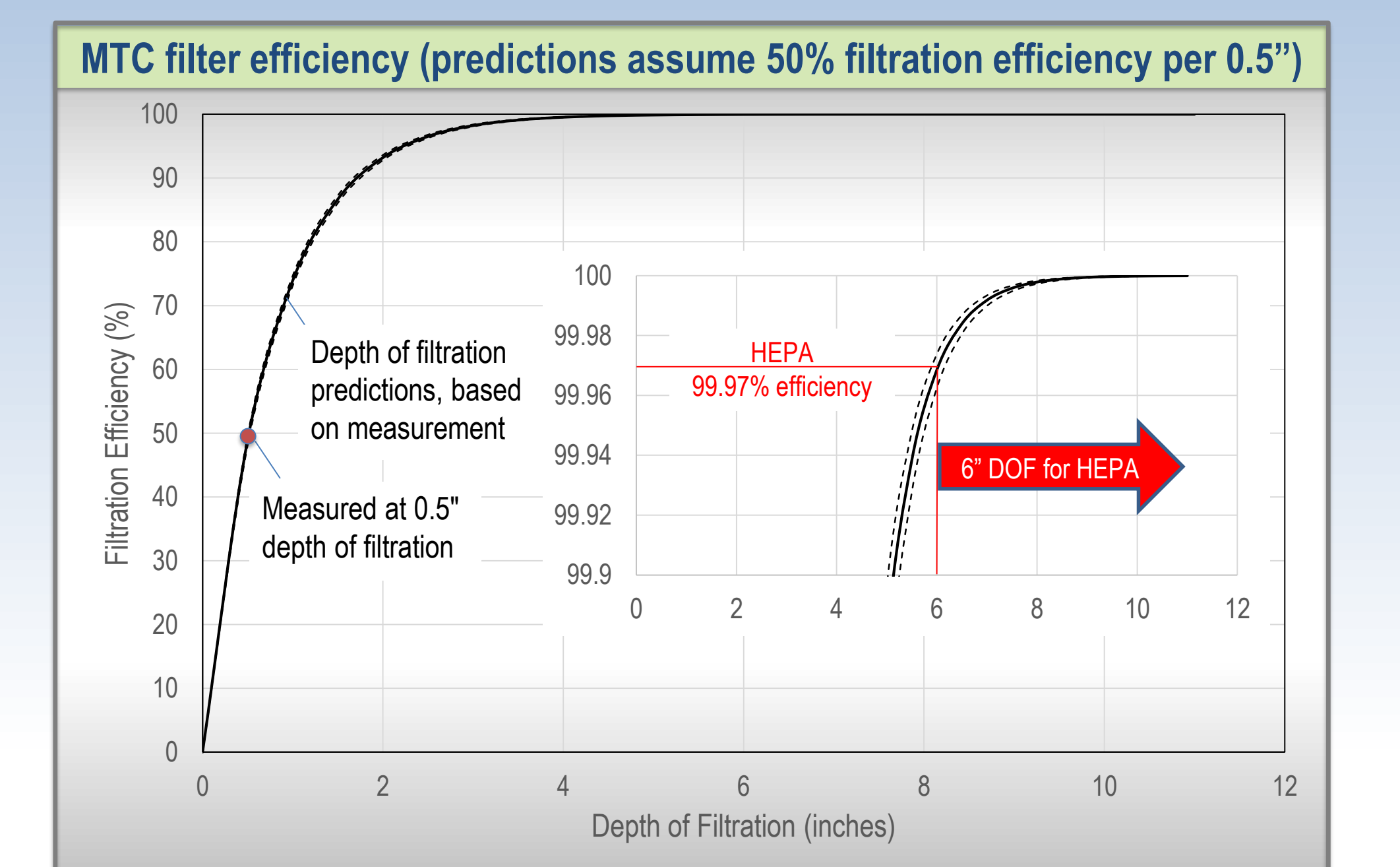
MTC Filter Prototypes

Pre-ceramic MTC Filter (2" depth)

MTC Filter (0.5" depth)

MTC filter pressure drop

- MTC filter prototypes have a low dP
- 6" depth of filtration est. for HEPA efficiency
- Optimization required



MTC filters that can survive a fire are likely to eliminate reliance on credited fire suppression systems