

# Improved Breathing Cartridge (IBC)

PM / PI Lawrence Barrett | [Lawrence.W.Barrett@nasa.gov](mailto:Lawrence.W.Barrett@nasa.gov)

## EXECUTIVE SUMMARY

The Fire Cartridge (FC) is designed to work with the Emergency Mask (EM) to protect the crew by cleaning the inhaled air in a post fire environment. The Improved Breathing Cartridge (IBC) is designed as a next generation FC with the lessons learned from years of building and testing the FC design, as well as novel catalyst materials to improve the performance and robustness of the cartridge. The FC was designed with minimal margin to save on mass, while the IBC was sized to have over 100% excess catalyst to achieve the required conversion, and still reduce the production cost. Kinetic data taken from another project was used to size the catalyst bed from the standard plug flow reactor conversion equation. The cartridge has been 3D printed and will soon be filled with the required levels of media. Testing has not yet been performed to determine final performance.

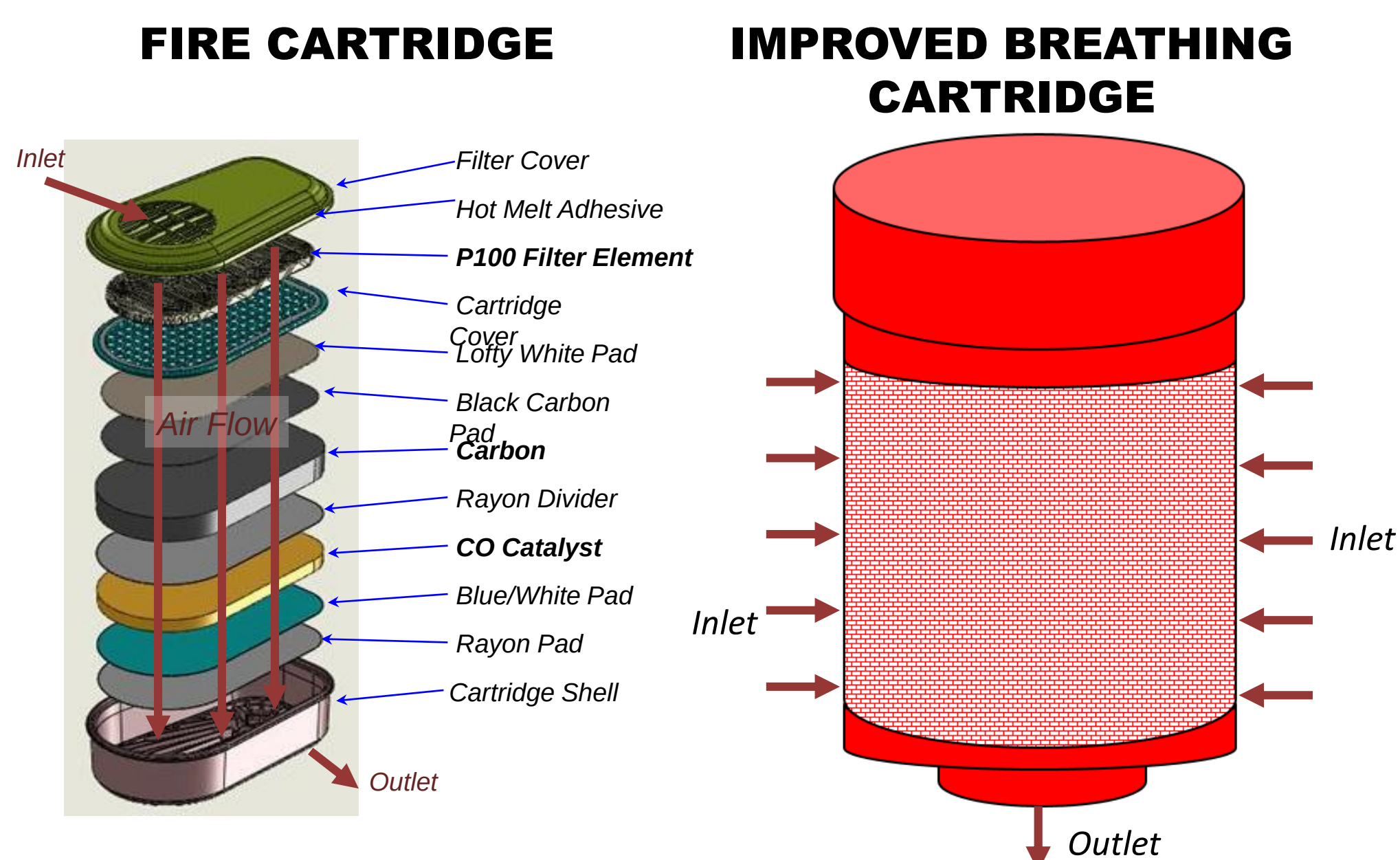
## INNOVATION

The IBC utilizes several design features that are the direct result of lessons learned from the previous cartridge.

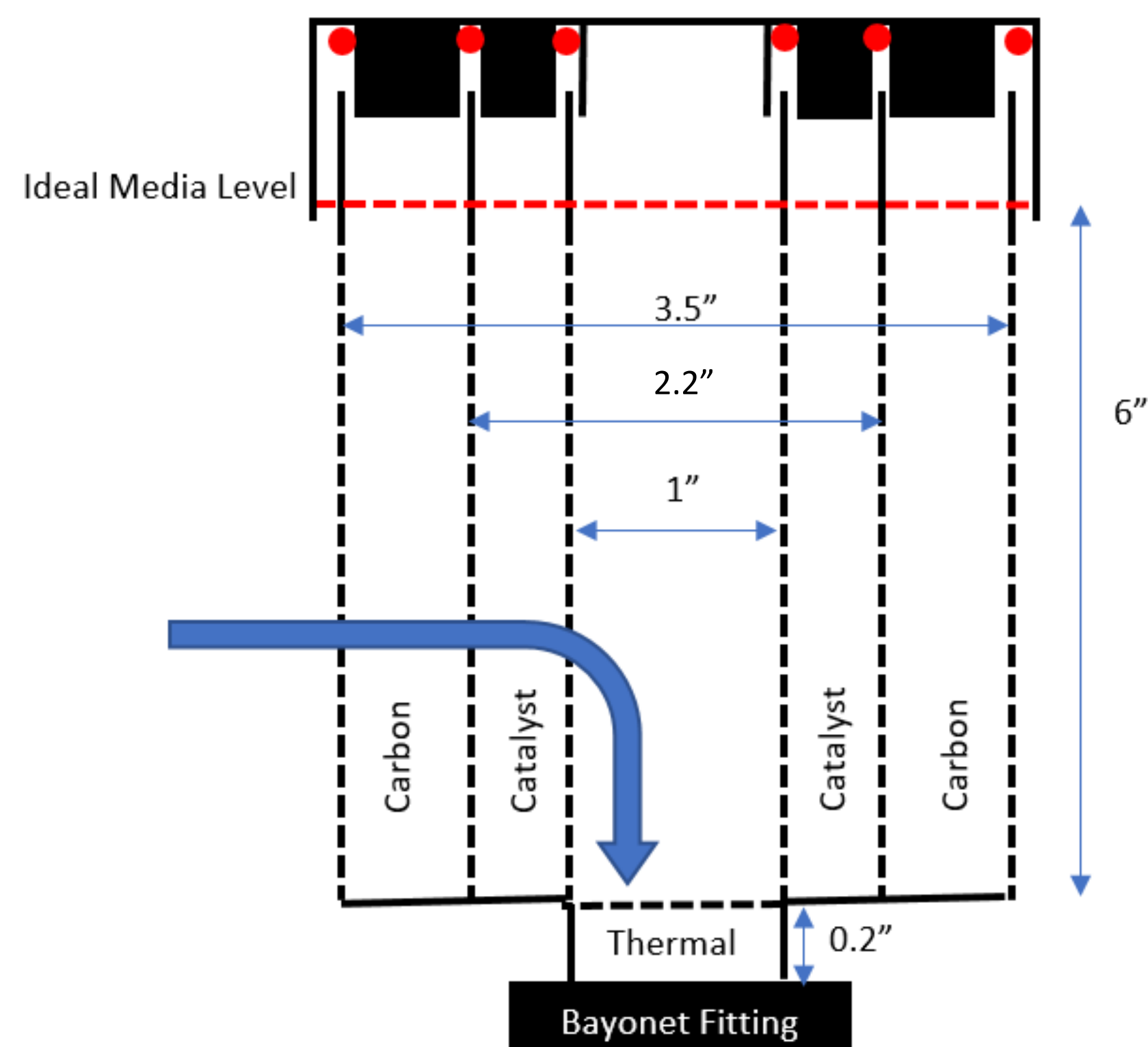
1. The different types of media are kept separate by a hard boundary, to prevent bed mixing and provide a uniform bed thickness.
2. Beds are filled in a direction orthogonal to the flow direction to remove variable bed thickness from the manufacturing process.
3. The Catalyst was switched with a newer material, that has a greater mechanical strength to prevent dusting, and is an order of magnitude cheaper than the old catalyst.
4. Annular bed shape allows for more uniform flow distribution.
5. A thermal mitigation bed was added to help soak up the heat of reaction and protect crew from thermal burns in their airway
6. New bed design means the fragile catalyst needs to be vibrated less than the old FC because this design allows the carbon bed to be filled and vibrated into place prior to filling the catalyst bed.
7. A screw-on lid allows for easier assembly than the ultrasonic welding, as well as greater variability in compression depth to increase acceptable tolerance on the bed fill level.

## COLLABORATION

Dr. Tim Nalette- NESC  
Dr. Dave Wickham- Reaction Systems



Flow paths for the new and old breathing cartridges, showing an uneven path on the FC, and a symmetrical path on the IBC



Interior cross section of the IBC showing dimensions for each of the packed beds

## OUTCOMES & INFUSION

The goal of this project is to produce a prototype cartridge of the IBC

- Kinetic data on the catalyst captured as part of the NESC FC study was leveraged to size the bed according to the plug flow reaction equation:

$$Vol = F_{CO}^0 \int_0^{0.9999} \frac{dX}{r_{CO}}$$

- Bed sizing tool was documented and archived as a future plug-and-play tool for packed bed projects.
- The housing of the cartridge has been 3D printed with a screw-on lid, allowing for adjustable compression of the bed.
- The catalyst was ordered and is in the process of being delivered from Spain.
- The prototype will be finished being assembled by the end of the FY, as soon as the catalyst is delivered.

## FUTURE WORK

The next step for this project is to test the prototype against CO under the same conditions as the original FC, and establish the level of improvements observed.

Once performance margins have been established, the project will be submitted to EC3 as a potential to replace the existing FC.