



## **Executive Summary: Next Generation Self-Contained Breathing Apparatus (SCBA)**

While current the self-contained breathing apparatus (SCBA) used by firefighters in low oxygen environments provides them with air to breathe, they are heavy, bulky, and present snag hazards. Consequently, firefighters and the International Association of Fire Fighters (IAFF) issued a requirement for a next-generation SCBA that is lighter and smaller, increases first responders' mobility, reduces their fatigue, and has a sleeker profile to both minimize snag and entanglement hazards and to enable them to work more easily in confined spaces. IAFF also envisions the new SCBA as having plastic instead of metal cylinders (thereby reducing shrapnel effects if the cylinders are punctured or otherwise compromised) which are mounted on a backframe that shifts much of the SCBA's weight from the firefighters' shoulders to their hips. The target customers for the technology are local, tribal, state, and federal firefighters.

Through a partnership with the IAFF and industry partners, the U.S. Department of Homeland Security Science and Technology Directorate's First Responders Group (FRG) developed a prototype SCBA pressure vessel technology that addresses all the stated requirements and, in addition, is compatible with current SCBA ensembles from all manufacturers. A Preliminary Field Evaluation with the Prince George's County (Maryland) Fire/EMS Training Academy assessed the new SCBA's form, fit, and function. Based on recommendations gathered during the evaluation, several improvements were made to the prototype. These included:

- Reconfiguring the placement of components, including the combination first stage regulator, valve, and gauge, to improve SCBA's profile, center of gravity, and ease of use
- Redesigning the pressure array cover to reduce, if possible, snagging hazards at the top corners and at the gauge/primary regulator site
- Reducing the length of the unit. Participants in the evaluation noted that, when climbing a ladder and entering a window, they found that the bottom of the prototype tended to catch on the window frame. The length of the unit is governed mainly by the length of the pressure vessel array.
- Increasing the stability of the SCBA on the wearer's back by moving the top strap attachment points on the harness toward the center line of the prototype and repositioning or improving the adjustability of the waist strap
- Improving the ease of removing and replacing the pressure vessel array, and
- Integrating methods for connecting the pressure vessel array to SCBA components that permit a variety of refilling options.

The modified (second) prototype was evaluated by the Chicago Fire Department, which recommended several further improvements, including:

- Reducing the cylinder array's weight by modifying the array to meet the more reasonable burst pressure requirements of the National Fire Protection Association's (NFPA) standards for non-fragmentary pressure vessels
- Lightening the various components while maintaining an appropriate level of ruggedness

- Removing the central joint between the two pressure cells constituting the pressure vessel, since the joint provides no observable benefits
- Making the pressure vessel shorter and narrower
- Reducing the protrusion of the top of the pressure vessel array
- Redesigning the harness system to increase stability on the wearer's back and afford greater adjustability
- Enabling the removal and replacement of the entire pressure vessel array, with cover and manifold, for easy servicing, and
- Evaluating the serviceability of the cover with regard to water and liquid absorption, cleaning frequency and methods, decontamination, and heat retention.

The U.S. Department of Transportation tested the second prototype's cylinders and manifold—a requirement before the cylinder array could be pressurized. The National Institute for Occupational Safety and Health and NFPA tested the full second prototype. These tests demonstrated that the SCBA could be certified to applicable industry requirements. Industry partners elected not to incorporate any of these additional recommended improvements into the design of the prototype and opted not to commercialize the technology. Although the cylinder array/flat pack offered a much reduced profile, improved mobility, and improved weight distribution—all significant benefits for first responders—the field assessments' criticism that the unit was still too long indicated the need for a redesign. Coupled with the weak economy, such a redesign required an investment that industry partners felt outweighed the potential benefits of bringing the technology to market.

The first responder community still needs a next-generation SCBA that will increase firefighter safety and mobility and reduce fatigue, and FRG remains committed to providing it. To that end, FRG has reviewed its efforts to date and identified weaknesses in both the design of the project's operational requirements and the SCBA project contract with the performers. Based on lessons learned, FRG is refining its process for developing operational requirements and establishing contractual terms that will require performers to fulfill those requirements and, at the end of the development phase, either commercialize the technology or give the technology to FRG to find a third party who will commercialize it.

In September 2013, FRG issued a Broad Agency Announcement (BAA) requesting rapid prototyping of technical solutions to meet a wide range of first responder needs. FRG is eager to hear, among the responses to the BAA, new proposals for a next-generation SCBA, and welcomes interested businesses and academics to submit their ideas.