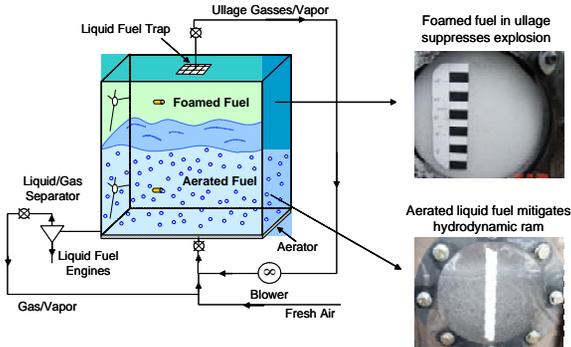


Technology

Hydrodynamic ram and ullage explosion in fuel tanks can cause extensive damage to aircraft. FuelShield™ protects fuel tanks against such occurrences by the simple flip of a switch. When activated, FuelShield™ generates bubbles in the liquid fuel and fuel foam in the ullage (vapor space above liquid).

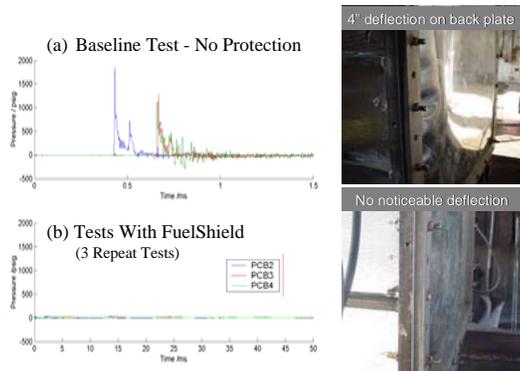
How it works



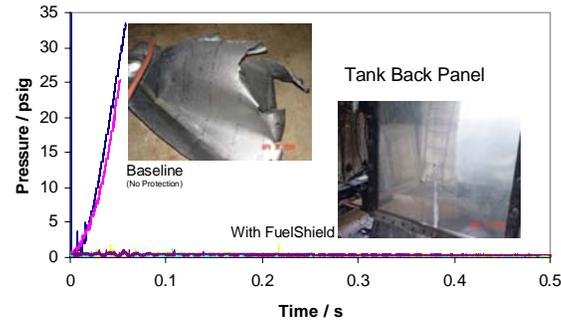
The two components of FuelShield™ (bubbles and foam) can be implemented separately or in combination with a synergistic effect. The system is designed to interface with commercial off-the-shelf equipment currently used in aircraft fuel systems.

Proof of concept tests at WPAFB show that, for a 40"x40"x40" fuel tank impacted by inert fragments, FuelShield™ (a) mitigates hydrodynamic ram and (b) suppresses ullage explosion.

(a) Hydrodynamic ram mitigation



(b) Ullage explosion suppression



FuelShield™ vs. Competition

Hydrodynamic Ram: There are no proven technologies for hydrodynamic ram mitigation to compare to FuelShield™. Fuel management and rigid foam backed structural panels have been examined but are not considered viable.

Ullage Explosion: FuelShield™ is compared with 3 commercially available technologies in the table below. FAA/Boeing's recent OBIGGS/FRS for B747 reduces the ullage oxygen concentration to 12%. This reduces the flammability of a heated CWT, but does not completely eliminate the explosion hazard.

ITEM	OBIGGS	Open-Cell Foam	In-Tank Fire Suppression	FuelShield™
Key Limitations	complex	maintenance problems	no acceptable agents as yet	none
Expendables	none	none	small	small
On-demand use	yes	no	yes	yes
Space/Weight	large	medium	medium	small
Reliability	medium	medium	unknown	high
Power	high	none	none	low
O&M	medium	major	medium	medium
Hazard	oxygen leakage	none	accidental release	none
Cost	high	low	medium	medium

FuelShield™: Since a single system provides protection against both hazards, the cost, weight, and volume penalties are reduced by roughly 50% for each hazard. Furthermore, its modular design, compatibility with existing fuel systems, on-demand activation capability, low maintenance, low initial and operating costs, and ease of repair in the field make it a viable candidate for both new and existing aircraft.



Market Opportunity

Hydrodynamic ram and ullage explosion can lead to structural damage and fuel loss that result in mission failure or total aircraft loss (roughly \$30 to \$160 million per plane for JSF and F-22, respectively.) In the Vietnam War, approximately 40% of aircraft losses were attributed to fuel systems hits. Since 1986, the Live Fire Test law (LFT, 10 U.S.C. 2366) requires testing the survivability of weapons systems sufficiently early in the program to allow any design deficiencies to be corrected.

Improvement in fuel tank survivability is needed in all types of fixed- and rotary-wing military aircraft as well as certain ground vehicles, ships and missiles. Such improvement is of interest to Air Force, Navair, Army AATD and their contractors including airframers and fuel tank system manufacturers. Of particular interest are newer systems such as fighter planes (JSF), bombers (C-17), helicopters (V-22) and reconnaissance planes (Global Hawk).



The estimated market for FuelShield™ in military aircraft is \$1.3 billion over the next 13 years. Our strategy is to focus first on this market. Other markets include commercial aircraft, ships, ground vehicles, and storage and transportation systems for fuels and flammable chemicals. The importance of the commercial aircraft market is indicated by the Air France Concorde and TWA800 crashes, attributed to hydrodynamic ram and ullage explosion, respectively, and since 9/11/2001, by the desire to protect commercial aircraft against ground fire, MANPADS and bombs placed near the fuel tanks.

Current Status

Lab scale tests have been conducted at BlazeTech in a shock tube and in a combustion chamber to simulate hydrodynamic ram and ullage explosion, respectfully. Gunfire validation tests in a 40"×40"×40" fuel tank have been conducted at WPAFB with inert fragments (See (a) and (b) on back page) and HEIs. Both small and large scale tests yielded the following results:

- Bubbles attenuate the ram pressure pulses by greater than 97% from the baseline
- Fuel foam completely suppresses the flame

Our strategy is to license with developmental funds. We are seeking strategic partnerships with aircraft fuel tank system manufacturers and airframers for manufacturing and marketing FuelShield™. The benefits to the licensee for the military aircraft market include participation in new aircraft systems such as JSF, and the ability to upgrade the capability and extend the operational life of existing systems such as the V-22, C-17, F/A-18E/F and A-10 – all with minimum technological risks. Also, the technology provides licensees with a competitive barrier consisting of a proprietary technology (patent pending), know-how, specialized equipment and calculation methods.

Management Team

Dr. N. Albert Moussa, president of BlazeTech and a national authority in fire and explosion, originally developed the FuelShield™ concept. He has published over 100 papers and reports and one book. He has served on national committees and as an Associate Editor for the ASME Journal of Energy Resources Technology. He received several Awards and Certificates of Appreciation, most notably in 2000, the Engineer of the Year Award by the New England Section of the American Institute of Aeronautics and Astronautics. Also taking part in this effort is Dr. Venkat Devarakonda, co-developer of FuelShield™, who specializes in design, experimentation, and analysis. They will be assisted by Dr. Darrel Robertson, aeronautical engineer, Mr. Gary Burgner, propulsion engineer, and senior consultants specializing in marketing, sales, and finance.

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BlazeTech

FuelShield™

The Only Protection Against Hydrodynamic Ram and Ullage Explosion



**A Partnering/Licensing
Opportunity for Airframers and
Fuel Tank System Manufacturers**

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