

# BlazeTech

## *Bringing Science to Safety*

Since its founding in 1987, BlazeTech has solved numerous one of a kind problems in industry and government. Our mission/vision is to develop innovative, timely and cost effective solutions that protect lives, property and the environment against accidents, terrorism and unintended adverse impacts of technology. We are seeking strategic partners to commercialize our technologies and software.

### Our Market



Aerospace and Defense



Fire and Explosion



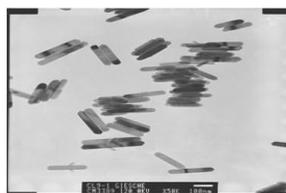
Munition and Propellant Safety



ChemBio Defeat



Energy and Environment



Nanotechnology

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# OVERVIEW

## Core Competencies

- Aircraft Survivability and Vulnerability
- Fire, Explosion, and Reactive Dispersion
- Risk Analysis of Extremely Hazardous Chemicals and Systems
- Environmental Safety
- Defeat of Chembio Agents in Air and Water Distribution Networks
- Laser Material Interactions
- Combustion and New Energy Technologies

## Our Services

- Contract R&D
- Consulting
- Technology Assessment
- Safety & Risk Assessment
- Specialized Testing
- Training
- Accident Reconstruction
- Expert Witness in Litigation

## Our Customers

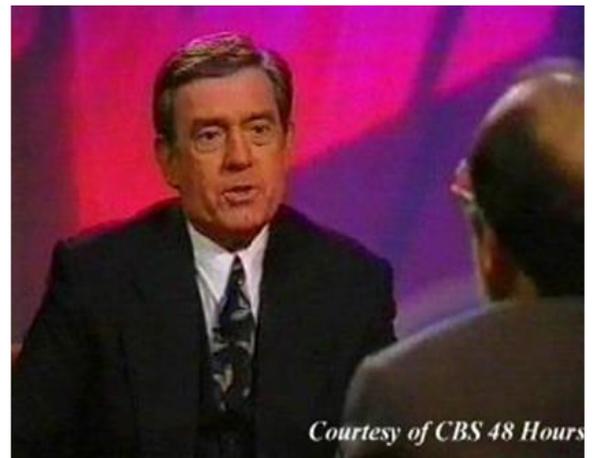
- Government agencies (DoD, DoT, DoE, EPA, FAA, NASA)
- Aircraft and aircraft subsystem manufacturers
- Power plants
- Chemical processors
- Environmental services companies

## Resources

- In house specialized instruments and labs, and working relationship with larger test facilities in government
- Proprietary software: ADORA, BlazeTank, HotSurf, PoolFire, Overpressure, Cookoff and H<sub>2</sub>O fate
- Expertise with specialized commercial and government software: FLUENT, DYNA 3D, CTH, ERAM

## Media Coverage

Our fundamental and quantitative understanding of accidents and their causes has enabled us to forewarn about major disasters before they happened, namely, the crash of Boeing 747 TWA 800, and of Concord Air France 4590. This has earned us national and international media coverage by CBS, BBC, NY Times, Wire magazine, The Telegraph and other news agencies. Recent media interviews include the potential fire hazards of Personal Digital Assistants aboard aircraft in the NY Times and US News World Report.



Dan Rather interviewing BlazeTech president Dr. Albert Moussa

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## Overview

In the commercial market we analyze the safety of aircraft systems and components and how to protect against accidents. In the military market, we analyze the vulnerability and survivability against gun-fire threats. We perform pre-test predictions, design full scale tests and analyze the results to assist our clients. We developed innovative protection methods.

### Hot Surface Ignition & Fire Suppression in Aircraft Engine:

We performed hot surface ignition tests on full scale aircraft (F-18 and AV-8B) and on a simulated engine nacelle (F-16). Thus we are able to characterize the conditions leading to ignition and how to avoid them. Our results can be applied to other aircraft.



Testing of F/A-18 Hornet

**Aircraft Fuel Tank Protection:** We developed a novel method to protect tanks against hydrodynamic ram and ullage explosion, called Fuel Shield™. We built a brass board system and proof of concept tests were carried out successfully on 40" x 40" x 40" cubical tank at an Air Force facility. The fuel tank was protected successfully against both hydrodynamic ram and ullage explosion produced by gun-fire.

### Unprotected

### Protected with FuelShield™

#### Hydrodynamic Ram

4" deflection on back plate



4" deflection

No noticeable deflection



Negligible deflection

#### Ullage Explosion



Plate ruptured



Plate perforated but not damaged

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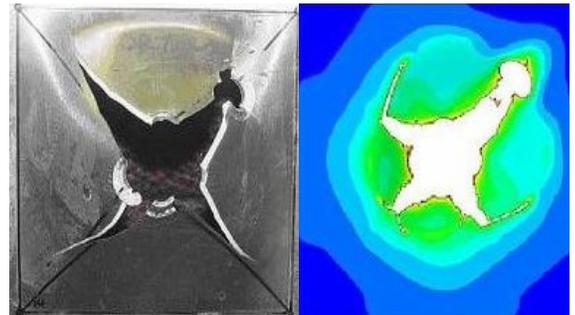
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**Soldier Protection in a Vehicle Engulfing in Fire:** We have developed a system to protect incapacitated soldiers trapped in a vehicle disabled during combat. The present Automatic Fire Extinguishment System protects against an IED but its effects are short lived. Our system activates afterwards and protects against re-flash fire and heat from an external fire that engulfs the vehicle. We have built a prototype to protect a 96 ft<sup>3</sup> instrumented box simulating a cab and tested it successfully against a large-scale fire.



**BlazeTech simulated cab subjected to a large-scale pool fire**

**Combined Fragment/Pressure Loading:** In combat, the plate is typically perforated first by a fragment and then pressure loaded by blast, hydrodynamic ram or fuel vapor explosion. Under pressure loading, cracks propagate from the hole enlarging it, and may even lead to plate rupture. We have characterized this weakening effect of the hole by testing, engineering models and numerical simulation. Our engineering models are fast running suitable for engagement analyses.



**Excellent agreement between test (left) and simulation (right) of pressure loading of a plate with a central hole.**



**Accurate airspeed indicator even when flying in adverse atmospheric conditions**

**Improved Airspeed Indicator:** We developed an air speed indicator that performs accurately when flying through severe storms or volcano eruptions. It measures the concentration of water/ice/ash particles in the air stream and corrects for its effect on the air speed reading. If the particle concentration were to exceed a critical limit, an alarm would be activated for the pilot to take action.

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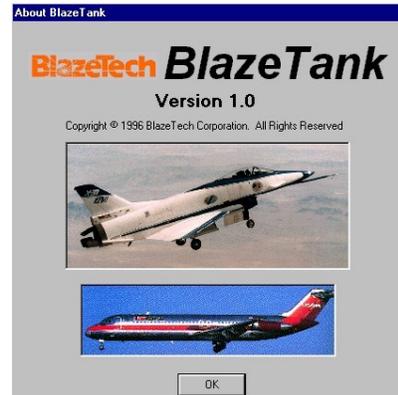
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# FIRE AND EXPLOSION

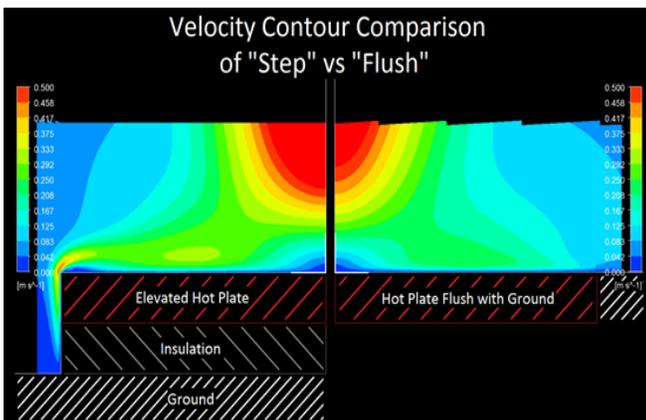
## Overview

In this market, we analyze highly unusual fires and explosions involving often combinations of materials for which the overall behaviors are unknown. We worked on gaseous, liquid and solid materials covering Class A, B, C and D fires. We evaluated halon replacement agents and developed new fire detection and suppression systems.

**BlazeTank:** We developed a fast running engineering software that predicts the flammability, ignition, deflagration and overpressure in fuel tanks under a wide range of conditions. It accounts for fuel tank geometry, fuel properties and various types of ignition sources. For aircrafts, it accounts for the flight profile and the effect of altitude.



Flammability, Fire and Explosion Software



ANSYS Fluent outputs of natural convection on hot plates

**Standardized Hot Surface Ignition Test:** In a binational program, we designed a standardized test for hot surface ignition. Ideally, the surface should be flush with ground while practically it had to be elevated by a step. Using ANSYS Fluent, we calculated the velocity (shown to the right) and temperature contours for both cases. We identified the size of a region near the plate center where the effect of the step can be neglected thereby simplifying the plate design.

**Particle Mass Flux Probe:** We developed a novel probe for the characterization of particle laden flows in the opaque, harsh, transient environment of a blast. This probe measures the gas flow properties (temperature and static and dynamic pressures) as well as the particles mass fluxes. The probe performed well in full-scale explosion tests by the military.



BlazeTech Mass Flux Probe

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# FIRE AND EXPLOSION

**Flameless Ration Heater:** We tested the FRH, an electrochemical pad containing magnesium. The concern was the wetting of these pads if damaged during transport or storage. The hydrogen produced by the water-magnesium reaction was measured and the potential build up of flammable gas in enclosures was modeled. Also, the effectiveness of major Class D fire suppression agents were evaluated against magnesium fires. We revised the MSDS for the FRH to include proper safety measures.



An FRH is used with every MRE



Large scale test of a Magnesium Fire

**Flash/Fire Discriminator:** BlazeTech's fire/flash discriminator measures time-resolved radiative emission from dry bays at high speed and uses it to detect impact flashes and differentiate them from fires. In 36 tests this detector performed very successfully:

- Zero false positives and zero false negatives
- Fast detection of all fuel fires in <6 ms except for 2 outliers (14 and 16 ms)



Flash/Fire Discriminator



Aerosol Pyrometer

**Aerosol Pyrometer:** We built a two-wavelength pyrometer to rapidly measure the surface temperature of burning aerosol particles accounting for light scattering effects. Typical pyrometers measure the temperature of surfaces not tiny particles. Ours can be used to study soot and slag formation and soot burn-out in various combustion systems (engines, furnaces and boilers).

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# MUNITION AND PROPELLANT SAFETY

## Overview

This market focuses the accidental or intentional discharge/activation of extremely hazardous materials such as explosives, reactive materials and fuels. We predict the hazard distances using our own specialized software; and we perform risk analyses to identify strategies and develop alternative solutions for unsafe conditions. Our clients are in the munition, propellant, and petrochemical industries.

### Prediction of Formation and Atmospheric Dispersion of Toxic Species During Fires/Explosions:

ADORA is the premier Environmental and Safety Analysis tool used for determining the environmental impact of intentional or accidental discharge of any hazardous chemicals, particularly when they react during dispersion, such as:

- Open burn and detonation of munitions and waste
- Fire and explosion in chemical warehouses
- Nuclear, biological, and chemical releases
- Spills of chemicals that react with moisture in the air



Our tests in SNL blast chamber that can handle up to 1 kg TNT

**Scaling Slow Cook-Off of Munition:** We have developed a methodology using small-scale tests and modeling to predict the response of full-scale munition. We designed critical tests that were performed at Sandia National Lab. We predicted successfully the available test data of PBXN-109. We are extending our model to other munition and evaluating various mitigation strategies. We wish to piggy-back on planned full-scale tests of munition or propellants for additional validation.



We tested cryogenic fuel pool fires

**Rocket/Missile Launch Hazards Modeling:** BlazeTech modeled the pool fire, unconfined vapor explosion, and toxic dispersion associated with accidental releases of propellants during pre launch and launch operations. We examined liquid and solid rocket motors, and hybrid engines in the Atlas Centaur, Titan, Delta, and AMROC systems. Propellants included liquid oxygen and hydrogen, hydrazine compounds, and nitrogen tetroxide.

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This Business Area concentrates on modeling air and water quality along with predicting contamination in chemical and biological accidents or attacks and developing solutions to real life problems. Our forte is to add key phenomenology that expand the capabilities of classical methods.

**H<sub>2</sub>OFate:** This software predicts the fate and transport of a chemical, biological, or radiological contaminant entering a municipal water distribution network either by accident or intentionally. H<sub>2</sub>OFate models the reactions of contaminants and residual disinfectants with each other and with the distribution systems pipe walls. Some applications:

- Provides vulnerability assessment for city planners
  - Assists in the development of risk management plans
  - Optimizes sensor placement for effective monitoring
- As a bonus, the software evaluates potential energy efficiency measures in the network.

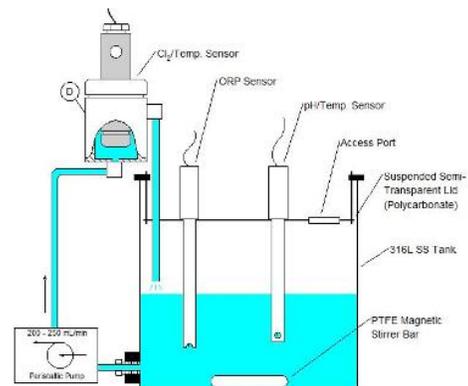


Hazard contours (red) after contaminant release into a drinking water distribution network .



BlazeTech Multi Phase Shock Tube

**Toolbox for Properties of Biological Slurries:** We measured the properties of biological slurries that are needed to perform computational analyses with CFD and hydrocodes. Specifically, we determined the equation of state (EOS) and developed models for thermal and chemical inactivation kinetics, shock speed, density, surface tension, dynamic viscosity, heat capacity, thermal diffusivity, and particle size distribution as functions of key process parameters such as slurry concentration, temperature, pressure, surface age, and strain rate.



BlazeTech reactor for the study of the neutralization kinetics of bacteria due to heat and oxidizers

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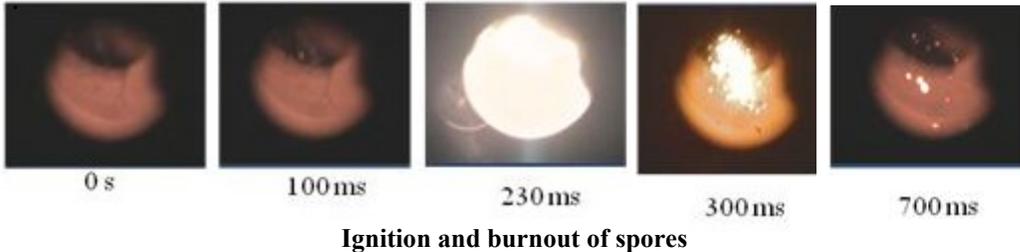
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# CHEMBIO DEFEAT

**Defeat of Biological Agents by Combustion:** For a government client, we characterized key properties of *Bacillus anthracis* spores and its simulant including thermo-physical, ignition, combustion and explosion properties. We developed specialized equipment that client used in their BioSafety Level-2 facility. The results were useful in developing methods for defeating anthrax, and assessing collateral damage and mitigation strategies.



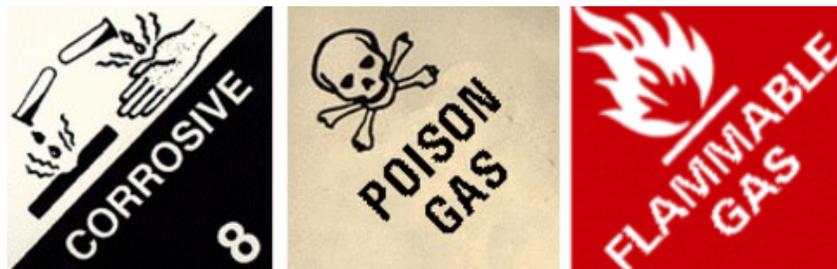
Instrumented Combustion Tube

**Interhalogens:** The high corrosive property of interhalogens makes them suitable for the defeat of a number of military targets. Supporting DTRA and the USAF, we used our ADORA software to calculate the concentration contours associated with the release of interhalogens into the atmosphere. Drawing upon our deep knowledge of these reactive chemicals, we assisted the USAF in the design of a large scale test facility to evaluate the effectiveness of interhalogens; and we developed a technology to improve their safe handling and storage.



Our Engineer in Protective Gears

**PC CHRIS:** The U.S. Coast Guard developed a series of manuals collectively called the Chemical Hazards Response Information System (CHRIS) to assist decision makers in dealing with emergencies involving accidental releases of chemicals on land or water. The cornerstone of the CHRIS system is the Hazardous Chemical Data Manual, which provides two pages of highly detailed information on each of over 1200 hazardous substances. An electronic edition of this 20 pound, 2700 page manual called PC CHRIS is now available from BlazeTech.



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In fossil fuels, we developed innovative multi-fuel combustors to satisfy both energy and environmental requirements. In renewables we developed biomass combustor, demonstrated solar and wind systems, audited energy conservation in plants, and worked on a smart grid software. Renewables enable the military to use local resources and to reduce the logistics of fuel delivery and their associated risks. Drawing upon this broad experience, we assist clients in selecting the most appropriate suite of technologies for their application.

**Low NO<sub>x</sub> Burner:** Our proprietary preheated fuel burner design addresses early NO<sub>x</sub> formation in coal combustion for a cleaner burn. Our early proof of concept tests in a 3 million Btu/hr facility showed significant NO<sub>x</sub> reduction. This technology is suitable for power plants, industrial boilers, and furnaces.



Preheated fuel burner



Damaged incinerator



Close up of damaged incinerator

## Volatile Organic Compounds (VOCs)

**Incineration:** The failure of an incinerator in handling the VOCs emitted by a fuel conditioning process was investigated. We determined that the emission was cyclical in nature, which was overlooked in the design of the incinerator. Catalytic and thermal incinerators were surveyed and a high thermal inertia system was selected suitable for handling the time varying VOC load.

**Fluidized Bed Combustion:** We developed an advanced concept in Fluidized Bed Combustion to improve performance. This project involved analysis, critical tests on a bench scale cold flow model and a plan for validation tests on a larger scale fluid bed combustor at DOE.

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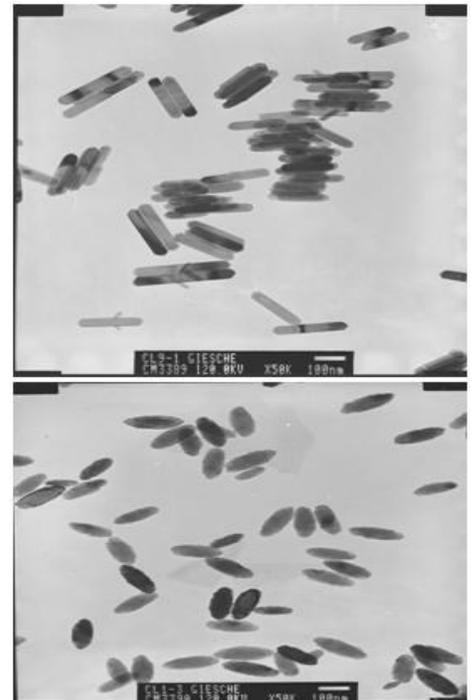
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## Overview

In the nanotechnology market we are continuing to develop specialized instrumentation for nanoparticle characterization, and methods to improve the agglomeration behavior of nanoparticles and their filtration from process gases. This helps companies develop new nanotechnology-based products and improve their QA/QC processes.

### Size and Aspect Ratio Distribution of Ellipsoidal Particles:

We performed polarized light scattering measurements on Hematite nanoparticles synthesized by aging aqueous  $\text{FeCl}_3$  or  $\text{Fe}(\text{NO}_3)_3$  solutions at  $100^\circ\text{C}$ . Samples were extracted at various times during their synthesis and were suspended in water for our measurements. We inverted the polarized light scattering data collected at various scattering angles and polarization states using our proprietary inversion algorithms to determine the cross sectional diameter and aspect ratio distribution of the suspension.



Hematite nanoparticles

## Nanoparticle Instrumentation

**Polarized Light Scattering Instrument:** Works based on elliptically polarized light scattering concept. The instrument is used to determine size, shape, and structure of particle samples in suspension.

**Polarized Light Extinction Spectrometer:** Provides morphology characterization of non spherical nanoparticles and agglomerates.



Polarized light scattering instrument

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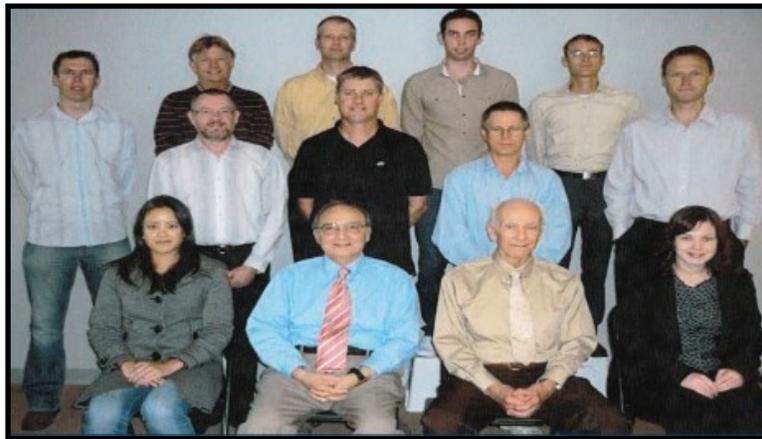
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# TRAINING

## Overview

One of the many Professional Services offered by BlazeTech is Training, drawing upon the specialized know-how we have developed in-house. Two of our most successful courses are in the areas of Aircraft Fire and the Chemical Hazard/Risk Assessment. Courses are offered at BlazeTech as well as at client sites.

**Aircraft Fire Hazards, Protection and Investigation Course:** While commercial air transport is very safe, the advent of new technologies poses fire safety challenges that will be treated in this three-day course. We discuss and analyze initiating events, their evolution, design issues, protection methods, and forensic implications. Lectures will include Personal Digital Equipment and Li/Li-ion battery fires, flammability of carbon fiber and glass fiber composites, emerging aviation fluids, engine fires, fuel tank fire/explosion, fire detection and suppression, and fire/explosion pattern recognition in aircraft accident investigations. Videos and photographs of real events and controlled tests are used in our integrated approach. The course benefits professionals who work with commercial aircraft, helicopters, or UAVs including design, operation, maintenance, safety, testing, accident investigation and risk analysis. For a military audience, we cover the above as well as the survivability under gun-fire, hydrodynamic ram and blast threats.



**BlazeTech course given at client site in Australia**

**Chemical Hazard/Risk Assessment Course:** This course focuses on off-site consequence analysis of the accidental release of extremely hazardous chemicals that pose the greatest hazards in industry. These include explosives, reactive chemicals, interhalogens, fuels and cryogenics. We discuss specialized software, databases and experiential know-how that enables one to assess such hazards accurately without being overly conservative. We cover fire, explosion, toxic releases and the potential of domino effects as one hazard triggers another. The course is useful to hazard/risk analysts, safety managers, plant operators and designers, and fire protection brigades.

### **For additional information, contact:**

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