Fundamentals of Explosives

short course on
Chemical & Physical Principles including blast effects, detection, hazards & HMEs.

May 12-14, 2025

This course provides an overview of the various aspects involved in explosive work. It examines the chemistry of explosives, the physics of detonation waves and initiation, and safe handling. Explosive output and its coupling to surroundings, will be discussed.

Chemistry

Chemical makeup of explosives—minimum requirements to be an explosive and synthetic principles. Initiation of explosives—role of hot spots, critical diameter & detonation failure. Evaluation—strength & safety. Highlighted will be the makeup of "homemade" explosives (HMEs).

Detonation & Shock Wave Physics

Shock and detonation waves. CJ and ZND models of detonation. Fundamentals of shock response of solids. Spall. Shock growth & decay. Graphical solution of plane-shock transmission. Initiation of detonation.

Air Blast

Air shocks in terms of source energy, thermodynamics, wave propagation & air flows. Methods of measurement for blast parameters, e.g. pressure & impulse and use of equations and graphs to describe near- & far-field blast will be presented.

Applications

Mining & military—setting requirements to match application--Gurney energy, overpressures, role of metallization, simple models.

Detection

Critique of the various technologies used in airport screening – bulk, trace & standoff. New challenges to detection.

COURSE INSTRUCTORS

Dr. James Kennedy, retired from Sandia & Los Alamos National Labs, specialist in initiation & Gurney model

Dr. Jimmie Oxley, Professor, Chemistry, U of Rhode Island; specialist in explosive safety and analysis.

Dr. Blaine Asay, retired from Los Alamos National Lab, specializes in non-shock initiation, DDT, and shock physics.

Dr. Nick Glumac, Professor Mech Eng. U of Illinois, specialist in combustion, reactive flows, spectroscopy.

Dr. Kenneth Graham, Fellow, Insensitive Munitions & Explosives, Aerojet Rocketdyne, 50-year career focuses on explosive testing.

Dr. O. Ted Strand, retired Livermore National Lab, PDV inventor.

REGISTRATION FEES: should accompany registration.

*No refunds to participants who fail to substitute or cancel at least 5 working days before course begins. Registrants are responsible for their own travel and lodging arrangements. Sponsor reserves the right to accept or decline registrations. If course is cancelled or goes virtual, attendees may request registration refund

Additional Classes

May15: Explosive Safety emphasis on best practices, accidents, and thermal analysis of explosives ($900)

May15-16: Dynamic Diagnostics covers principal experimental techniques for measuring explosive behaviors. Basic explosive firing-site operations & planning & data analysis ($1850)

May 19: Photon Doppler Velocimetry Hands-on experience with setup, discussion of technique, equipment, data processing and safety ($1100)

Registration Form*

Name _____

Affiliation: _____

Phone: _____

E-Mail: _____

Check class
Fundamentals May 12-14 ($1950)____

Safety May 15 ($900) __

Dynamic Diagnostics May 15-16 ($1850) ____

Hands-on PDV May 19 ($1100) ____

Checks payable H.E.R.E. or call with credit card. Credit card Visa/MC (only) to H.E.R.E

Call, email or mail to

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Attn: Jimmie Oxley
Kingston, RI 02881
Phone (401) 559-1120 joxley@uri.edu

May classes held at University of Rhode Island
Classes can be scheduled at your facility.

You can schedule a class at your facility. Call or email Dr. Oxley. 401-874-2103; joxley@uri.edu
More complete descriptions can be found at http://energetics.chm.uri.edu/?q=node/95

BASIC COURSES level denoted as B = baccalaureate (bachelors), T = technician, G = graduate]

Fundamentals of Explosives (B): overview of chemical and physical principles; military and commercial explosives; explosive output; shock waves, detonation and initiation; explosive devices; homemade explosives, IEDs, peroxides; explosive detection.

Explosive Operations: Safety and Protocol (B and T): a walk through the safety manuals; explosive storage; relevant regulations; required testing; safe handling; history of explosive accidents.

ENERGETIC MATERIAL BEHAVIOR AND PERFORMANCE

Stability, Compatibility and Surveillance (B): thermal safety; analysis of thermal stability and compatibility; surveillance issues; cookoff – thermal explosion models.

Propellants & Combustion (G): combustion of energetics – theory and experiments; flame spread and convective burning; flame spread in cracks; surface ignition; propulsion equations.

Detonation & DDT (G): detonation models and phenomenology; detonation theory – math and thermodynamics; Detonation Shock Dynamics (DSD) model; deflagration-to-detonation (DDT) phenomenology and testing; DDT Theory and modeling.

Explosive Systems Hazards (G): explosive behavior related to hazards; DDT phenomenology and testing; flame spread in damaged explosives; non-thermal ignition sources – mechanical shear, electrical case studies; initiation sources from ordnance; insensitive high explosives (IHEs).

Energetic Nanomaterials (G): combustion propagation in pyrotechnics; thermites and metastable interstitial compositions.

EXPLOSIVE APPLICATIONS AND EFFECTS

Dynamic Diagnostics (B): Experiment time lines. *Measurement techniques:* witness plates, make switches, detonation waveshaping, gas guns, pressure gauges, embedded gauges, ultrahigh-speed framing & streak cameras, interferometry, pulsed radiography. *Applications:* device performance, wave arrival times, pressure histories in media, HE output, shock-wave evolution, detonation spreading.

Air Blast and Structural Response (B): blast wave from high explosives – scaling laws; blast from deflagration; themobarics; coupling to structures; stress & strain; single-degree-of-freedom system analysis; pressure-impulse failure estimates.

Materials Response under Impulsive Loading (G): emphasizes inert material response to dynamic loads; detonation-driven shocks; material structure & mechanical behavior; dynamic response experiments; inelastic continuum mechanics & material damage; material response modeling & wave codes.

Explosive Components and Train Design (B): design approach; low-energy electroexplosive and laser-ignited devices; high-power detonators and arrays; slapper detonator (ESAD) technology; explosive train design & statistical reliability testing; hazards with devices and trains; manufacturing explosive devices.

Warhead Mechanics (B): shaped charges and jet penetration; Gurney model and combination with other physics; detonation wave interactions and effects on metal; fuzes, especially in-line electronic safing, arming & firing (ESADs).

Pyrotechnics (B): general principles and chemistry of pyrotechnics; roles of pyrotechnics: heat, ignition, light, thrust; pyro devices; flares and luminosity;

EXPLOSIVES CHEMISTRY

Terrorism Issues (B): terrorist threats; peroxide explosive preparation, performance and safety; pre-blast detection of explosives; fragment hazards; performance codes by law enforcement; case studies.

Environmental Issues with Explosives (B): general explosive issues and toxicity; explosive residue from blast; fate & transport of explosives in soil, water, plants; sampling protocols & analysis methods.

Laboratory Analysis and Forensics (B): review of actual protocols for explosive analysis, for specific explosives; operational safety; case studies from former forensic scientists.

Material Characterization & Processing (B): characterization & effects of particle morphology; controlling particle morphology – recrystallization; formulation; particle-size effects of safety and performance; iRDX.

Explosive Synthesis (G): synthesis of common military explosives; new materials and preparations; advanced and high-nitrogen energetic materials.