Fundamentals of Explosives

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

May 3-5, 2016

This course examines the chemistry of explosives, the physics of detonation waves and their initiation, and the issues involved in safe handling and characterizing these. Explosive output and coupling to surroundings, with specific application to structural response, will be discussed. We will address terrorist bombings, the gathering, analysis and interpretation of evidence, improvised explosives, and explosive detection. Lecturers are internationally known experts.

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.

Applications

Mining and military—setting requirements to match the application--Gurney energies, overpressures, role of metallization, simple models.

Detection & IED's

Critique of the various technologies used in forensics and airport screening – bulk, trace & standoff. New challenges to detection. Post blast examination & laboratory analysis

Hazards

Causes of inadvertent ignition and detonation, identification of hazards and mitigation, deflagration-to-detonation transition.

COURSE INSTRUCTORS

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

Dr. Jimmie Oxley, Professor, Chemistry, U of Rhode Island; Co-Director of DHS Center of Excellence Explosives Detection, Mitigation, Response & URI Forensic Science.

Dr. Maurice Marshall, OBE, retired Defense Science & Technology Laboratory UK; specialist in forensics of blast.

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

REGISTRATION FEE: $1525 (US) should accompany registration.

Fee includes course materials, coffee breaks, and a dinner. The fee must accompany the registration form. Space is limited and early registration is encouraged. The sponsor reserves the right to accept or decline registrations and to cancel the course and return all registration fees if enrollment is insufficient.

Optional **Hands-on Explosive Analysis** Friday May 6- includes half day lecture & 2-3 hr in lab with covering IR & Raman spectroscopy, NMR, GC & LC mass spectroscopy of explosives ($510, US)

No refunds will be made to participants who fail to substitute or cancel by at least 5 working days before the course starts.

Registrants are responsible for their own travel and lodging arrangements. See http://www.chm.uri.edu/forensics/introexp.shtm

Registration Form

Fundamentals of Explosives
May 3-5, 2016

Name _____

Title: _____

Affiliation: _____

Phone: _____Fax: _____

E-Mail: _____

Optional Friday ($510)

Checks payable to Chemistry Dept;
University of Rhode Island,
($1525) or ($1635)

Credit card Visa/MC (only) to H.E.R.E
Call or mail to
University of Rhode Island; Chemistry Dept
51 Lower College Rd.
Attn: Jimmie Oxley
Kingston, RI 02881

Phone/fax (401) 874-2103 ph/fax
joxley@chm.uri.edu

Purchase of "Aspects of Explosive Detection" Marshall & Oxley (ed) may be made for an additional $100.

You can schedule a class at your facility. Call or email Dr. Oxley. 401-874-2103; joxley@chm.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.