



The Principles of Electrical Fires and Explosions

2- day SHORT COURSE

Tutor: Dr Vytenis Babrauskas

Dates: 31 January – 1st February 2013

**Venue: Hyatt Hotel, Fisherman's Wharf
California, USA**

Fees: US\$ 795

US\$ 650 (for Fire and Materials 2013 delegates)

THE COURSE AIMS AND OBJECTIVES

The course presents the unifying principles of electrical fires to fire investigators, fire service personnel, forensic engineers, insurance adjusters, and other professionals interested in understanding the causes of fires. At the completion of this course, the attendee should be equipped with a basic understanding of the mechanisms by which the third leg of the fire triangle—"source of heat"—can be caused by electric current or static electricity. Attendees should already have had some previous instruction on the basics of electricity, as only a very brief review of the elementary principles of electricity will be made.

Most other courses on electrical fires available to fire investigators (a) start at a very basic level and run out of time before more advanced topics can be covered; and (b) focus primarily on examples of electrical fires, and do not systematically develop the principles that underlie all electrical fires. It is the purpose of the present course to take up where such courses leave off and it is assumed that attendees already have some knowledge of the more practical aspects of investigating fires in electrical devices or appliances. The first 2/3 of the course is devoted to developing a good understanding of the principles that underlie all electrical fires. The remainder focuses on a variety of devices and appliances that can undergo an electrical fire. This is illustrated by color photos of failed devices, and the participants will be given information in the last portion of the course on how these practical failures can be understood in terms of the basic principles of electrical fires.

Existing instructional materials for fire investigators (e.g., Kirk's Fire Investigation and NFPA 921) address the basic level courses, but these are not sources that contain more advanced information. The technical source of the information that will be given in the present course comes from the **Ignition Handbook** (by Vytenis Babrauskas; Fire Science Publishers, 2003), which is the only reference currently available for these advanced studies. During the course, the Handbook will act as a reference source and will reduce the need for extensive note-taking by the participants. Consequently, attendees may wish to procure a copy of the handbook for that purpose. Numerous handouts will be provided to cover additional, newer material. The course also covers electrical explosions, and one of the handouts will provide reference material on that topic.

The knowledge gained in this seminar will then allow interpretations of burn patterns to be made that are consistent with the state of the art of ignition theory, as it pertains to electrical causes.

About the Tutor: Dr Vyto Babrauskas was the first person to ever receive a Ph.D. degree in Fire Protection Engineering. He headed the fire test method development programs at NIST for 16 years before becoming a consultant.

Vyto has taught graduate-level engineering courses at the University of British Columbia and at Worcester Polytechnic Institute, has given hundreds of lectures and presentations and is the author of some 300 papers on fire safety. He is the Author of the authoritative treatises "Ignition Handbook" and "Heat Release in Fires", and serves in an editorial capacity for several fire safety journals.

In recent years, he has been regularly teaching classes to fire investigators on fire science principles.

Further details from <http://www.doctorfire.com>

COURSE OUTLINE

DAY 1

Part I – General principles pertinent to electrical fires

- What is an electrical fire?
- Statistics on electrical fires
- Fundamentals: Ohm's Law, sine waves, simple circuits, energy-storing components (inductors, capacitors)
- Energy sources: Static electricity, electric current
- Electrical discharges (all types, applicable both to static electricity and electric current)
 - Breakdown phenomena
 - Paschen's Law (air)
 - Dielectric strength of solid insulators
 - Definitions of *arc* and *spark*
 - Spark ignition of flammable atmospheres
 - Types of discharges under steady-state conditions (i.e., with electric current flow, not for static electricity)
- Ignition modes involving electric current
 - Sparking or arcing in the gas phase
 - Arcing across a carbonized path
 - Glowing and other forms of overheating (ohmic heating)
 - Ejection of hot particles
 - Miscellaneous phenomena
- Time for fire to initiate from a defect
- Static electricity
 - General principles (charge separation, accumulation, discharge)
 - Means whereby charge separation occurs
 - Types of discharges
 - Electrostatic charging and discharging of solids/ persons and apparel/ granular materials/ liquids
- Lightning
 - Electrical characteristics
 - Ignition from lightning
- Other atmospheric discharges (St. Elmo's fire, ball lightning)
- Electromagnetic waves and particulate radiation
 - Radio transmitters, eddy currents, dielectric heating
- Minimum energy requirements for ignition
 - Gases/ Dust clouds/ Liquids/ Solids
- Are there minimum values of voltage, current, or power that must be exceeded for ignition to be possible?

DAY 2

Part II – Practical applications and failures of devices

- Problems with wiring devices
 - Wiring in 120 and 240 VAC branch circuits
 - Electric outlets, plugs, and connections
 - Busbars, switchboards, panelboards
 - Insulated distribution cables
 - Service drops, high-current-capacity conduits
 - Branch-circuit wiring conduits
 - High-voltage insulators
 - Power and distribution transformers
 - Wiring in motor vehicles
 - Wiring in aircraft
- Problems with other appliances or devices (not wiring devices)
 - Flammability of cabinets of electric or electronic appliances
 - High-limit switches and thermostats
 - Electric batteries
 - Electric blankets, mattress pads, heating pads
 - Heat tapes and heat cables
 - Electric heaters
 - Electric cooking appliances
 - Electric water heaters
 - Electric dryers and washers
 - Electric lamps and lighting fixtures
 - Electronic devices
 - Computer equipment
 - Televisions
 - Radio and audio equipment
 - Cellular telephones
 - Surge suppression devices
- Protective devices
 - Over-current devices (circuit breakers, fuses)
 - Ground-fault circuit interruption devices (GFCIs)
 - Arc-fault circuit interruption devices (AFCIs)
 - Explosionproof or intrinsically safe equipment
- Arc beads—cause or victim?
- Time for fire to develop from defect
- Research status concerning electrical fires
 - Most work has been done in Japan; almost no ongoing research in the US

Comments, Open Discussion