Coffee Break Training - Fire Protection Series

Hazardous Materials: Detonation or Deflagration?

No. FP-2014-48 December 2, 2014

Learning Objective: *The student will be able to explain the difference between detonations and deflagrations.*

News reports of disasters often quote witnesses who said they heard some sort of explosion connected to the event. While deaths, injuries and damage resulting from explosions are devastating in every way, there are distinctions in the model fire codes among explosion types.

In general, an explosion is the rapid and violent expansion of gases, which may include a shock wave, that can disrupt materials and enclosures in the vicinity. Explosions can result from chemical changes (such as rapid oxidation), physical changes (such as catastrophic failure of pressure vessels), or atomic changes (nuclear fission or fusion).

The model codes differentiate between two types of explosions based on the shock wave travel speed.

Deflagration	An exothermic (heat-emitting) reaction, such as the extremely rapid oxidation of a flammable dust or vapor in air, in which the reaction progresses through the unburned material at a rate **less** than the velocity of sound (1,125 feet per second or 340.29 meters per second (m/s) at sea level). A deflagration can have an explosive effect.
Detonation	An exothermic reaction characterized by the presence of a shock wave in the material that establishes and maintains the reaction. The reaction zone progresses through the material at a rate **greater than** the velocity of sound (1,125 feet per second or 340.29 m/s at sea level). The principal heating mechanism is one of shock compression. Detonations have an explosive effect.

The shock from the deflagration of a fertilizer storage facility resulted in the damage to this single-family dwelling. (Federal Emergency Management Agency/Norman Lenburg)

The distinction between **deflagrations** and **detonations** exists to establish the code requirements for explosion control. In general, the codes allow deflagration effects to be mitigated through explosion relief, explosion prevention systems, or barricades. Meanwhile, items that detonate must be separated by barricades that are designed to withstand the rapid release of energy in an explosion and are fully confined, partially vented or fully vented, or by another effective method of shielding from explosive materials by a natural or artificial barrier.

Explosion control is a sophisticated engineering challenge that should be addressed only by qualified personnel.

For more information, consider enrolling in the National Fire Academy course "Hazardous Materials Code Enforcement" (R0615). Information and applications can be obtained at http://apps.usfa.fema.gov/nfacourses/catalog/details/10504.