



## **institute of makers of explosives**

### **Ammonium Nitrate Detonability Question**

**Issue:** Is ammonium nitrate (AN) prill a Class 1 explosive or not?

**Background:** Since the tragic 2013 incident at West, TX involving AN, some assert that AN has a TNT detonability equivalence of 0.72, a metric closely approaching the globally-accepted value of “ANFO” (ammonium nitrate fuel oil), a Division 1.5 explosive.<sup>1</sup> Others assert that the technical grade of AN (TGAN) used in the explosives industry is inherently “explosive” while the fertilizer grade (FGAN) used in the agricultural industry is not.

**Discussion:** AN is a stable, noncombustible chemical compound. The chemical structure of TGAN and FGAN is the same,  $\text{NH}_4\text{NO}_3$ . The only difference is the density of the finished prill. TGAN is less dense than FGAN.

AN is not an explosive. It has been classified as an oxidizer by the U.S. Department of Transportation (DOT) and by the National Fire Protection Association (NFPA) based on prescribed tests.<sup>2</sup>

While AN prill is not an explosive, it can detonate under extreme conditions such as shock from an explosion or intense and sustained heat because it contains an ammonium molecule ( $\text{NH}_3$ ) which acts as an inefficient fuel – meaning that there is not enough fuel to consume all the oxygen supplied by the  $\text{NO}_3$  molecule. In a fire, AN can melt<sup>3</sup> at 337 F° and decompose at 410 F°. This physical change increases the likelihood of a thermal explosion. Likewise, AN that is exposed to a shockwave from an explosion may be heated from the extreme compression to the point of decomposition and may detonate if the pressures are high enough and sustained long enough. When melted, there is no difference between FGAN and TGAN.

Determining a TNT equivalence based on this inefficiency has produced a range of results. The highest theoretical value in this range, based on the Thermodynamic Code “TDS”, predicts a 0.42, not a 0.72, TNT equivalence. This means that the maximum amount of energy that could be expected from a detonation of AN would be no more than 42% of same amount of TNT.<sup>4</sup> Other subject matter expert sources have predicted ratings as low as 0.25 TNT equivalence.<sup>5</sup> The explosive inefficiency of AN also accounts for the fact that not all product will contribute to the detonation.

**Recommendations:** Additional studies and testing may validate or lead to reducing the TNT equivalence for AN. Until testing shows otherwise, AN prill, if managed properly, is an inert material which will not detonate. In the meantime, emergency responders should be trained not to attempt to fight that have engaged AN and to evacuate at-risk populations.

---

<sup>1</sup> Blast Effects Caused by Explosions, US Army, London, 2004. The explosive value of ANFO is 0.75 TNT equivalence.

<sup>2</sup> DOT classifies AN prill as a Division 5.1 oxidizer meaning that “the material may, generally by yielding oxygen, cause or enhance the combustion of other materials.” NFPA uses four ratings for oxidizers that cover materials capable of increasing the burning rate of combustible materials and which may cause spontaneous ignition when in contact with a combustible material. Under this system, AN is a Class 2 oxidizer, with “4” being the most reactive.

<sup>3</sup> AN does not burn. It is its own oxygen source.

<sup>4</sup> “Ammonium Nitrate – Fertiliser, Oxidiser and Tertiary Explosive,” Dr. Martin Braithwaite, 10OCT2008. “Army Field Manual 5-250,” 15JUN1992, pgs. 1-2.

<sup>5</sup> Loss Prevention Data Sheet 7-89, FM Global, APR2013, predicts 0.33 TNT equivalence; Good Practice Guide for the Safe Storage of Solid Technical Grade Ammonium Nitrate, SAFEX, MAR2014, predicts 0.33 TNT equivalence; and the U.S. Chemical Safety Board in a letter to EPA on Docket EPA-HQ-OEM-2014-0328, 29OCT14, pg. 4, predicts 0.25 TNT equivalence.