United States
Environmental Protection
Agency

Occupational Safety
and
Health Administration

Bureau of Alcohol,
Tobacco, Firearms
and Explosives

EPA 550-S-13-001 August 2013

Chemical Advisory: Safe Storage, Handling, and Management of Ammonium Nitrate

The Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) ("we") are issuing this advisory[1] as part of an ongoing federal effort to improve chemical risk management, and to advance safety and protect human health and the environment. This advisory contains information on recent and past accidents involving AMMONIUM NITRATE (commonly referred to as AN), on the hazards of AN, how to manage these hazards, and appropriate steps for community emergency planning and proper emergency response. It is focused primarily on safe handling and storage of higher density, solid AN pellets and prills (a prill is a small bead) used in fertilizers. This advisory is intended to broadly disseminate lessons learned from recent incidents involving AN so that such incidents can be prevented in the future. Also provided is a list of information resources, including relevant codes and standards, industry publications, and applicable statutes and regulations that will help facilities handling AN and first responders better understand the hazards so they can effectively manage the risks. The information provided is not intended to cover all the hazards, safe practices or technical challenges associated with the manufacturing of AN; liquid fertilizers containing AN; manufacturing, storage or use of explosives or blasting agents containing AN; or the transportation of AN. For these particular situations, please consult other sources including the appropriate references, standards and regulations, cited at the end of this document.

ACCIDENTS

In general, AN is manufactured for use as a fertilizer and to produce explosives and blasting agents.[2] There are several other uses in the chemical industry, such as the production of nitrous oxide. These other uses represent a small fraction of amount of AN used in the US.

Although pure AN is stable at ambient temperature and pressure under many conditions, the chemical itself does not burn. AN is a strong oxidizer[3] and it supports and accelerates the combustion of organic (and some inorganic) material, increasing the fire hazard and complicating the fire fighting challenges. AN may explode when exposed to strong shock or when subjected to high temperatures in confinement.

Millions of tons of AN are produced annually in the US. Incidents involving AN are rare, but as is shown in the accidents below, they can have severe consequences. Most recently, on April 17, 2013, a fire at a fertilizer storage and distribution facility in West, Texas, resulted in a detonation of AN fertilizer stored at the facility, killing 15 people, including some of the firefighters responding to the fire. That incident remains under investigation,[4] but much has been learned from other AN explosions.

[1] The statements in this document are intended solely as guidance. This document is not a substitute for EPA, OSHA, ATF or other agencies' regulations, nor is it a regulation itself. It cannot and does not impose legally binding requirements on the agencies, states, or the regulated community. The measures described in this document may not apply to a particular situation based upon the circumstances. This guidance does not represent final agency action and may change in the future, as appropriate.

[2] A blasting agent is any material or mixture, consisting of a fuel and oxidizer, intended for blasting, not otherwise classified as an explosive and in which none of the ingredients are classified as an explosive, provided that the finished product, as mixed and packaged for use or shipment, cannot be detonated by means of a No. 8 test blasting cap when unconfined (see 29 CFR 1910.109(a)(1))

[3] An oxidizer is a material that readily yields oxygen or other oxidizing gas or that reacts readily to promote or initiate combustion of combustible materials.

[4] The precise quantity and form of AN has not been definitively established. We intend to update this advisory as we learn more about the incident and as we identify additional best practices.

- On October 2, 2003, a fire and explosion occurred in a double story farm warehouse in St. Romain en Jarez, France, involving 3 to 5 tons of AN stored in bags. This incident killed 26 people, 18 of whom were firefighters. In this incident, improper storage methods are thought to have played a role.

- On September 21, 2001, a massive explosion occurred in a warehouse at the Azote de France fertilizer factory in Toulouse, France, involving 200-300 tons of AN, which was stored in bulk in a hangar. The explosion resulted in the death of 30 people, 2500 injuries, the destruction of the factory, and an additional 10,000 buildings being heavily damaged. The exact cause of this accident remains unknown. Storage of incompatible material with AN is believed to have been a factor.

We have learned several key lessons as a result of these accidents and additions studies of AN, including:

The conditions of storage and the materials co-located with AN while in storage are crucial to the safety and stability of the AN.

Explosions of stored AN are responsible for some of the worst chemical disasters on record. Several of these incidents, including two in Germany in 1921, occurred during attempts to break up large piles of solidified or caked AN and ammonium sulfate mixtures using explosives. In both cases, the initial blast intended to break up solid AN initiated an unintended general detonation of the AN or ammonium sulfate mixture.

AN will self-confine under some conditions. Adding heat, such as a booster charge intended to break up clumps, can initiate a general detonation of the AN.

Other large explosions have been triggered by fires involving AN in confined spaces, including the 1947 explosion in Texas City, Texas, of two cargo ships. In that case, the first ship is thought to have exploded due to a fire in the hold involving AN fertilizer that had been manufactured with a wax coating and stored in paper bags. The wax would have been one potential source of fuel for mixing with the AN, thus creating an explosive situation. The second ship exploded some time later, likely due to a fire caused by the first explosion. These two explosions resulted in deaths of nearly 600, including all but one member of the Texas City Fire Department.

As a result of such accidents and subsequent studies of the properties of AN, caked AN is no longer broken up with explosive materials, and organic material such as wax coatings are no longer used for AN fertilizer.

Our intent in issuing this advisory is to identify actions that should be taken as a result of the lessons learned from the more recent accidents involving AN. Similar to the corrective steps taken following the 1921 and 1947 incidents, this advisory emphasizes the safe steps that should become common practice in the industry and emergency response community in order to prevent the catastrophic loss of life and property damage.

Here are some of the things we have learned from accidents involving AN:

AN will self-compress/self-confine under some conditions, becoming much more likely to explode.

AN is at risk for explosion when stored near other material that can add fuel to the AN – such as grain, sugar, seeds, sawdust, and most especially petroleum fuels such as diesel.

AN is a powerful oxidizer and a rich source of nitrate, which provides energy to an explosion. Thus, the presence of fuel and/or heat (and especially both) near AN is a very high hazard situation.

INFORMATION ON HAZARDS

Hazard Classification

For the purpose of transportation, AN that contains less than 0.2 percent combustible substances and AN fertilizers are classified by the U.S. Department of Transportation (DOT), as oxidizers**. AN with more than 0.2 percent combustible substances is classified by DOT as an explosive.**[5] (see box below).

The National Fire Protection Association (NFPA) assigns an instability rating of 3 (in a range of 0-4) to AN, meaning AN is capable of detonation, explosive decomposition, or explosive reaction, but that a strong initiating source or confinement in extreme temperatures is required. AN can explode under certain conditions by adding energy (heat, shock), especially when contaminants are present or it is under confinement.

"Pure" ammonium nitrate is stable and will explode only under extraordinary circumstances. However, the addition of combustible materials such as sugar, grain dust, seed husks or other organic contaminants, even in fairly low percentages, creates a dangerous combination and the ammonium nitrate mixture becomes far more susceptible to detonation. This characteristic of ammonium nitrate underlies most of the advice and recommendations for safe handling contained herein.

Decomposition Chemistry

AN melts at 337° F (170° C) and begins to undergo decomposition when molten. Hazardous scenarios with AN can involve simple thermal decomposition initiated by external fire or other heating, self-sustained decomposition also known as "cigar burning," and detonation.

Decomposition creates toxic gases containing ammonia and nitrogen oxides. The resulting nitrogen oxides will support combustion, even in the absence of other oxygen. The resulting heat and pressure from the decomposition of AN may build up if the reaction takes place in a confined space and the heat

[5] *Explosive* means any substance or article, including a device, which is designed to function by explosion (*i.e.,* an extremely rapid release of gas and heat) or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion (see 49 CFR 173.50(a)).

and gases created are not able to dissipate. As the temperature rises, the rate of decomposition increases. In a confined space, the pressure can reach dangerous levels and cause an explosion that will include the detonation of the AN.

When dealing with a large quantity of AN, localized areas of high temperature may be sufficiently confined by the mass of material to initiate an explosion. The explosion of a small quantity of AN in a confined space (e.g., a pipe) may act as a booster charge and initiate the explosion of larger quantities (e.g., in an associated vessel).

During a fire in a facility where AN is present, the AN can become hot and molten which makes the material very sensitive to shock and detonation, particularly if it becomes contaminated with incompatible material such as combustibles, flammable liquids, acids, chlorates, chlorides, sulfur, metals, charcoal, sawdust, etc. If a molten mass becomes confined (e.g., in drains, pipes or machinery), it can explode.

Most types of AN do not continue to decompose once a fire has been extinguished. However, some types of AN fertilizers containing a small percentage of chlorides (e.g., potassium chloride) undergo a smoldering (self-sustaining) decomposition that can spread throughout the mass to produce substantial toxic fumes, even when the initial heat source is removed. These fertilizers that can self-sustain decomposition, known as "cigar burners" are normally compound fertilizers that contain between 5% to 25% nitrogen from ammonium nitrate, up to 20% phosphate (as P_2O_5) and chloride (which may only be present as a small percentage).

Contaminants

AN mixed with oil or other sensitizing contaminants may explode or detonate when exposed to fire or shock. Organic materials (e.g., packing materials, seed, etc.) will increase the likelihood of an explosion and will make the AN explosion more energetic.

AN may also be sensitized by certain inorganic contaminants, including chlorides and some metals, such as aluminum powder, chromium, copper, cobalt, and nickel.

As AN solution becomes more acidic, its stability decreases, and it may be more likely to explode.

Solid AN readily absorbs moisture, which can lead to caking, self-compression and self confinement. This in turn increases susceptibility to explosion in a fire.

The density, particle size and concentration of solid AN in a material, as well as the presence of other additives, affects the hazard of the material. The technical grade of AN is a lower density (higher porosity) prilled material. Higher density prills are used as fertilizer. AN can be fused with ammonium sulfate fertilizer or amended with carbonate materials to reduce its explosive properties. More information on additives is discussed in *Guidance for the Storage, Handling and Transportation of Solid Mineral Fertilizers* found in the Reference section. Solid fertilizers are usually coated with an inorganic, non-combustible anti-caking compound to prevent sticking and clumping.

AN in undiluted or pure form has a higher degree of overall hazard than when it is mixed or blended with compatible or non-combustible materials that can reduce the concentration. In general for fertilizer blends containing AN, the more nitrogen they contain, the greater the explosion hazard they pose. Blended fertilizers containing AN and chloride compounds and blended fertilizers containing AN contaminated with combustible materials or incompatible substances pose increased explosion hazards. A large number of blended fertilizers are produced from basic primary fertilizer products (e.g., ammonium nitrate, urea, and mono-ammonium phosphate) and natural materials (e.g., rock phosphate, potassium chloride) which can introduce contaminants. All such materials are not necessarily compatible with each other and some may produce undesirable effects when mixed with others. These undesirable effects can include, for example, chemical reaction(s) and physical effects (e.g. stickiness which can cause handling difficulties, moisture migration giving rise to caking tendency). Facilities can consult *Guidance for Compatibility of Fertilizer Blending Materials* listed in the Reference section to assess potential incompatibility. The Safety Data Sheet (SDS – formerly MSDS) of the AN product should be used as one source of information to assess the overall hazard. The effects of added components can only be determined after careful review of the SDS and other available hazard literature.

Confinement and/or the addition of fuel to AN creates a real danger of explosion. The addition of heat when either of these conditions exists can lead to disaster. Accordingly, the responder should quickly assess if AN has been involved in the fire and whether the AN has been compromised in any of these ways, and plan the fire response accordingly.

HAZARD REDUCTION

What steps should facility owners or operators take to reduce the hazards of AN during storage and handling?

Storage/Process Conditions to Avoid

Persons engaged in the handling, management or emergency planning for AN must be aware of the hazards of AN and ensure that the conditions that may lead to an explosion are not present. Measures that facilities should take to ensure the safe storage, use and handling of AN include:

- Avoid heating AN in a confined space.
    - Processes involving AN should be designed to avoid this possibility.
    - Avoid localized heating of AN, potentially leading to development of high temperature areas (e.g., AN fertilizer should not be stored near sources of heat such as steam pipes, radiators, hot ducts, light bulbs etc.).
- Ensure that AN is not exposed to strong shock waves from explosives. AN storage near high explosives or blasting agents must conform to ATF's Table of Separation Distances, Title 22 of the Code of Federal Regulations, section 555.220 (22 CFR 555.220).

- Avoid contamination of AN with combustible materials or organic substances such as packing materials, dust, seed, oils, and waxes.
    - If possible, do not co-locate AN, especially bulk AN in bins, with dust-producing organics such as grains or seeds.
- Avoid contamination of AN with inorganic materials that may contribute to its sensitivity to explosion, including chlorides and some metals, such as aluminum powder, chromium, copper, cobalt, and nickel.
    - Pay attention to the materials used to build storage areas and cribs. Wood and aluminum or other metals must be specially treated to prevent impregnation if they are going to be in contact with AN. Metal materials can be treated with epoxy tar or chlorinated rubbers to prevent corrosion of the metal and contamination of the AN.
- Maintain the pH of AN solutions within the safe operating range of the process. In particular, avoid low pH (acidic) conditions.
    - If possible, do not co-locate acids in an AN storage area.
- Keep molten or solid AN out of confined spaces, especially sewers or drains where it can react with organic materials there.

Certain specific safety and handling instructions (required and recommended) apply for safe handling and storage of AN[6] under certain conditions:

OSHA's standard for Explosives and Blasting Agents at 29 CFR 1910.109(i) contains requirements for AN stored in the form of crystals, flakes, grains or prills including fertilizer grade, dynamite grade, nitrous oxide grade, technical grade, and other mixtures containing 60 percent or more of AN by weight. AN should also be handled in accordance with safe practices found in *NFPA 400 Hazardous Materials Code, Chapter 11*.

Building Design

- Store only in one-story buildings and buildings with no basements, unless the basement is open on one side.
- Use fire resistant walls within 50 feet of combustible building or materials.
- Flooring in storage and handling areas should be constructed of noncombustible material or protected from impregnation by AN.
- Avoid installing, or remove or close off any open drains, traps, tunnels, pits or pockets into which molten AN can flow and be confined in the event of fire.
- Buildings should be kept dry and free of water seepage through roofs, walls and floors.
- Have adequate ventilation or be constructed to self-ventilate in the event of a fire to avoid pressurization.
- Do not place AN into storage when the temperature of the product exceeds 130°F (54.4°C).

[6] AN-based materials that are DOT Hazard Class 1 sensitive (explosives or blasting agents) must be handled and stored in accordance with requirements of OSHA's Standard for Explosives and Blasting Agents (29 CFR 1910.109) and ATF's Table of Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives or Blasting Agents (27 CFR 555.220) Facilities should also follow the NFPA 495- Explosive Materials Code, where applicable.

Storage in bags, drums or other containers

- Piles of bags, drums and other containers should be no closer than 36 inches below the roof or supporting beams.
- Bags should be stored no less than 30 inches from walls or partitions.
- Piles of bags, drums, and other containers should not exceed a height of 20 feet, width of 20 feet, and length of 50 feet, unless the building is of noncombustible construction or protected by automatic sprinklers.
- Maintain aisles of at least 3 feet width between piles.

Storage in bulk

- Bins for storing bulk AN should be kept clean and free of materials, which could contaminate the material. Bins should not be constructed of galvanized iron, copper, lead or zinc unless suitably protected. Aluminum or wooden bins should be protected against impregnation by AN.
- Piles or bins must be adequately sized, arranged and moved periodically to minimize caking. Height or depth of piles shall be limited by pressure-setting tendency of the product, but in no case should pile be higher than 36 inches below roof or supporting beams.
- Do NOT use dynamite, explosives or blasting agents to break up or loosen caked AN.
- Protect piles of AN from absorbing moisture from humid air by covering them with water-impermeable sheeting or using air conditioning.
- Do not store AN with organic chemicals, acids, or other corrosive materials, materials that may require blasting during processing or handling, compressed flammable gases, flammable and combustible materials or other contaminating substances. AN stores should be separated from incompatible substances by using separate buildings or 1 – hour fire resistant walls, or a minimum separation distance of 30 feet.

Fire Protection

- AN storage areas should be equipped with an automatic sprinkler system, or have an automatic fire detection and alarm system if the areas are not continuously occupied. This is especially important when the facility in question is close to the public surrounding the facility.
- Facilities should NOT store more than 2500 tons of bagged AN without an automatic sprinkler system.
- An automatic sprinkler system, if installed, should be provided in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.
- Suitable fire control devices such as hoses and appropriate portable fire extinguishers (AN is an oxidizer and not all fire extinguishers are appropriate) shall be provided throughout the warehouse and loading areas. Water supplies and fire hydrants should be available.
- Store AN fertilizer in separate buildings or separated by approved fire walls from organic, combustible or reactive materials, such as grains, wood or other organic materials, urea and urea compounds, flammable liquids or gases, corrosive acids, chlorates, chromates nitrites, permanganates or finely divided metals or sulfur.

- AN fertilizer should NOT be stored in the same building with explosives or blasting agents unless conditions in ATF's Table of Separation Distances of Ammonium Nitrate and Blasting Agents from Explosives and Blasting Agents, 27 CFR 555.220, are met.
- Prohibit smoking in AN storage areas.

We recommend that AN be stored in purpose-built facilities/buildings of non-combustible construction. Dust-producing organic materials, such as grain, seeds and sugar, should not be stored near AN. Some metal powders such as aluminum powder are equally dangerous. AN should be stored so as to ensure it is not contaminated by gasoline, diesel or other fuels, and is not subject to high heat (even in one small area of a large stockpile) or water infiltration.

COMMUNITY EMERGENCY PLANNING

What should communities do to understand and develop a plan for the risk associated with AN?

AN is a hazardous chemical covered under the OSHA Hazard Communication Standard. Therefore, facilities that handle and store AN are required by law to submit information regarding chemical hazards (including AN) to their State or Tribal Emergency Response Commission (SERC or TERC), Local Emergency Planning Committee (LEPC), and local fire department. This information must include the following:

1) a Safety Data Sheets (SDS) providing the chemical's hazard information and emergency response guidelines and
2) a Hazardous Chemical Inventory form that provides the quantity, storage types and locations of the AN at their facility.

We recommend that fire services visit any facility reporting AN, and that the conditions of storage and manner of handling be reviewed by fire service personnel. Fire service and other emergency responders should take note of the specific location(s), amounts and packaging of stored AN. Conditions of storage should be reviewed with the facility operator in light of the information provided in this document.

The LEPC in conjunction with the fire department should use this information to develop an emergency plan, in case of a fire or explosion involving AN or any other hazardous substance. The facility should consult with the LEPC to provide them the necessary information to develop the emergency plan, the elements of which should include:

- Identification of facilities and transportation routes of hazardous substances
- Description of emergency response procedures, on and off site
- Designation of a community coordinator and facility emergency coordinator(s) to implement the plan

- Outline of emergency notification procedures
- Description of how to determine the probable area and population affected by releases
- Description of local emergency equipment and facilities and the persons responsible for them
- Outline of evacuation plans
- A training program for emergency responders (including schedules)
- Methods and schedules for exercising emergency response plans

LEPCs should also ensure that members of the community (which would include potentially affected populations) are aware of the emergency plan and the actions they need to take if an accident occurs.

Local fire departments should use the information to determine what precautions they may need to take in responding to an accident at the facility and ensure the first responders have the appropriate training to respond to incidents involving AN.

Owners and operators of facilities holding AN are required to report the AN hazard to local response officials under the Emergency Planning and Community Right-to-Know Act (EPCRA). Unfortunately, that obligation is not universally understood, and so some facilities may fail to report. Fertilizer-grade AN is typically found at those businesses that provide direct logistical support to agriculture. This may include crop service operations, farm co-ops, grange stores and similar operations.

In the interest of community safety, it is often necessary and appropriate for first response officials to reach out to facility owners and operators, and determine if unreported risks are present in their community. Helping a neighbor, facility operator, or employer to understand and meet his obligations to the community and to workers is in everyone's best interest

EMERGENCY RESPONSE

Owner/operators of storage facilities should develop a site emergency response plan which includes:

- Coordination with local first responders
- Joint training with first responders if possible
- Employee training
- Community outreach
- Analysis of what may be at risk in a serious accident and appropriate planning
- Signs that clearly mark high hazard areas, safe areas, emergency contact numbers, firefighting equipment, and other essential area during an emergency response
- A site and area evacuation plan

Owners and operators of facilities holding AN have an obligation to ensure their community's first responders are aware of the hazards associated with the AN. Reliance on a report may not always be sufficient. Owners and operators should take a pro-active approach to reaching out to the emergency response officials in their location and ensuring that the hazards of AN are understood by the responders.

What do firefighters need to know when responding to an accident or fire involving AN?

Before responding to a fire involving AN, firefighters should ensure the community emergency response plan includes:

- AN hazard information and emergency response guidelines
- Quantity, storage types, and locations of AN at facilities in their community
- Specific response procedures; including a decision process to determine under which conditions a fire should be fought or whether the fire should be allowed to burn
- Evacuation procedures for the community
- Training requirements for all response personnel
- A schedule for exercising the response plan related to AN accidents

When responding to a fire where AN is stored; firefighters should:

- First consider if they can safety fight the fire or whether they should just let it burn, move to a safe location, and focus on evacuating nearby residents and preventing further safety issues for the surrounding community.

To determine whether or not it makes sense to fight the fire or to let it burn, firefighters and emergency responders should consider the following information:

- Firefighters should not fight an AN fire and everyone, including fire fighters, should be evacuated to a safe distance if they observe any of the following:
  - A fire involving AN is judged to be out of control;
  - The fire is engulfing the AN; or
  - Brown/orange smoke is detected, indicating the presence of nitrogen dioxide (which is toxic); or
  - A rapid increase in the amount/intensity of smoke or fire in the area of AN storage.

- If firefighters consider it safe and appropriate to respond to a fire involving AN, then the following information should be considered:
  - AN fires should be fought from protected locations or maximum possible distance. Approach a fire involving or close to AN from upwind to avoid hazardous vapors and toxic decomposition products. Self-contained breathing apparatus (SCBA) of types approved by the National Institute for Occupational Safety and Health (NIOSH) should be used to protect personnel against gases.
  - Use flooding quantities of water from a distance as promptly as possible. It is important that the mass of AN be kept cool and the burning be quickly extinguished. Keep adjacent fertilizers cool by spraying with large amounts of water. When possible and appropriate, only use unmanned hose holders or monitor nozzles.

- Do NOT use steam, CO_2, dry powder or foam extinguishers, sand or other smothering agents.[7]
- Ensure maximum ventilation of the AN storage container as quickly as practical to prevent heat and pressure buildup. This is different than ensuring maximum ventilation of the entire building or structure where the AN is stored. Ventilation of the structure should be conducted only in a manner to limit fire spread and growth and should be minimized until a suppression water supply is established.
- If practicable and safe to do so, attempt to prevent AN from entering the drains where explosive confinement could occur. Remember AN may be washed into drains by fire water, but it can also melt and flow without impetus from water.
- Prevent or minimize contamination of water bodies or streams to reduce the potential for environmental effects.

INFORMATION RESOURCES

CODES AND STANDARDS

NFPA codes and Compressed Gas Association (CGA) standards are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing various viewpoints and interests to achieve consensus on safety issues. These codes and standards are not binding but may be adopted by reference into laws or regulations. Users of the codes and standards should consult applicable federal, state and local laws and regulations.

NFPA has developed a code for storage of AN, including mixtures containing 60 percent or more by weight of AN, and a code for explosives that would apply to blasting agents and explosives containing AN. These codes are listed below:

NFPA 400 — Hazardous Materials Code, Chapter *11 - Ammonium Nitrate Solids and Liquids*. (2013). Also see Annex A.11 in this document and Annex E: Properties and Uses of Ammonium Nitrate and Fire-Fighting Procedures.

NFPA 495 — Explosive Materials Code (2013).

National Fire Protection Association
1 Batterymarch Park
PO Box 9101
Quincy, MA 02169-7471
Phone: 800-344-3555 (toll free)
Website: http://www.nfpa.org/freeaccess

[7] Keep in mind that ammonium nitrate is an oxidizer – that is – it provides its own oxygen and once combustion begins, it cannot be smothered. Moreover, the combination of heat and confinement will accelerate combustion, perhaps to the point of detonation.

Safe Practices for the Production of Nitrous Oxide From Ammonium Nitrate, CGA G-8.4 (January 2013). Compressed Gas Association, Inc., Chantilly, VA
http://www.cganet.com/customer/publication_detail.aspx?id=G-8.4

GENERAL REFERENCES

Storing and Handling Ammonium Nitrate, INDG230 (First published 8/96, Reprinted 11/04). Health and Safety Executive (HSE), United Kingdom http://www.hse.gov.uk/explosives/ammonium/

Safe Storage and Handling of Ammonium Nitrate (AN), Technical Note 60, (28/02/2006), SafeWork, South Australia. http://www.safework.sa.gov.au/uploaded_files/SSAN_Storage.T60.pdf

Safe Practice: Safe Storage of Solid Ammonium Nitrate. (2013). Resources Safety, Division of Mines and Petroleum, Government of Western Australia (WA), East Perth, WA.
http://www.dmp.wa.gov.au/documents/Code_of_Practice/DGS_COP__StorageSolidAmmoniumNitrate.pdf

Guidance for the Storage, Handling and Transportation of Solid Mineral Fertilizers. (2007). European Fertilizers Manufacturers Association, Brussels, Belgium, www.efma.org

Guidance for the Safe Handling and use of Non-conforming Fertilizers and Related Materials (Producers). (2003). European Fertilizers Manufacturers Association, Brussels, Belgium, www.efma.org

Guidance for the Safe Handling and Use of Non-conforming Fertilizers and Related Materials for Fertilizer Importers, Distributors and Merchants. (2004). European Fertilizers Manufacturers Association, Brussels, Belgium, www.efma.org

Guidance for the Storage of Hot Ammonium Nitrate Solution. (2005). European Fertilizers Manufacturers Association, Brussels, Belgium, www.efma.org

Guidance for Compatibility of Fertilizer Blending Materials. (2006). European Fertilizers Manufacturers Association, Brussels, Belgium, www.efma.org

The above five guidance documents from European Fertilizers Manufacturers Association can be found on the following webpage:

http://www.productstewardship.eu/site/index.php?id=259

Ammonium Nitrate and Mixed Fertilizers Containing Ammonium Nitrate, FM Global Property Loss Prevention Data Sheet 7-89. (April 2013). FM Global, Johnston, Rhode Island.
http://www.fmglobal.com/page.aspx?id=04010200 Free access with registration

Ammonium Nitrate Handling, (2013). Bunn Fertiliser, Ltd.
http://www.bunnfertiliser.com/infocentre/bunnhealthsafety/ammoniumnitratehandling/

Ammonium Nitrate, Industrial Grade, Technical Information. (2011) Dyno Nobel Inc. http://www.dynonobel.com/files/2010/04/1Ammonium_Nitrate_LomoDonora-Industrial.pdf

Ammonium Nitrate, Nutrient Source Specific (NSS) Fact Sheet, No. 22 International Plant Nutrition Institute, Norcross, GA http://www.ipni.net/publication/nss.nsf/0/67265A0AC9302CC5852579AF0076927A/$FILE/NSS-22%20Amm%20Nit.pdf

Fire Protection Guide to Hazardous Materials, 14th edition. (2010). National Fire Protection Association, Quincy, MA.

Guide No. 140 for Oxidizers , *Emergency Response Guidebook*. 2012. US Dept. of Transportation, Pipeline and Hazardous Materials Safety Administration. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Hazmat/ERG2012.pdf

EPA Chemical Accident Investigation Report, Terra Industries, Inc., Nitrogen Fertilizer Facility, Port Neal, Iowa. (January, 1996). U.S. Environmental Protection Agency, Region 7, Emergency Response and Removal Branch, Kansas City, KS. http://www.epa.gov/emergencies/docs/chem/cterra.pdf

West Fertilizer Explosion and Fire. (2013). U.S. Chemical Safety Board http://www.csb.gov/west-fertilizer-explosion-and-fire-/

The National Safety Council has a data sheet *Ammonium Nitrate Fertilizer, Data Sheet I-699.* (1991) that discusses the health hazards, properties, and precautions for safe storage and handling of AN fertilizer.

National Safety Council
1121 Spring Lake Drive
Itasca, IL 60143-3201
Phone: (800) 621-7269 (toll free) or (630)-775-2199 (Library)
Website: http://www.nsc.org

The Fertilizer Institute (TFI) possesses information on various fertilizer products, including AN, and their uses.

The Fertilizer Institute
425 Third Street, SW, Suite 950
Washington, DC 20024
Phone: (202) 962-0490
Website: http://www.tfi.org

ResponsibleAg (RA) is a Fertilizer Code of Practice management system that helps facilities establish basic Environmental, Health, Safety and Security (EHS&S) performance practices. ResponsibleAg is a joint venture of the Agricultural Retailers Association (ARA) and The Fertilizer Institute (TFI). ARA also has a *First Responder Guidance* for use by agricultural retailers, LEPCs and local first responders. For more information, contact:

Agricultural Retailers Association
1156 15th Street, NW
Suite 500
Washington, D.C. 20005
Phone: 202-457-0825
Website: www.aradc.org

For more detailed information on the safe handling practices for storage of explosive materials which may contain AN, please consult the following Safety Library Publications (SLPs) developed by the Institute of Explosive Makers (IME).

- *Construction Guide for Storage Magazines,* IME SLP No. 1 (September 2006).
- *The American Table of Distances*, IME SLP No. 2 . (October 2011).
- *Suggested Code of Regulations for the Manufacture, Transportation, Storage, Sale, Possession, and Use of Explosive Materials*, IME SLP No. 3. (October 2009).
- *Handbook for the Transportation and Distribution of Explosive Material,* IME SLP No. 14. (April 2007).
- *Safety in the Transportation, Storage and Use of Explosive Materials,* IME SLP No. 17 (October 2011).
- *Recommendations for the Transportation of Explosives, Division 1.5, Ammonium Nitrate Emulsions, Division 5.1, Combustible Liquids, Class 3, and Corrosives, and Liquids, Class 8 in Bulk Packaging*, IME SLP No. 23. (October 2011).
- *Explosives Manufacturing and Processing Guide to Safety Training,* IME SLP No. 25. (May 2011).

SLPs are available at http://www.ime.org/ecommerce/products.php?category_id=13

Institute of Makers of Explosives (IME)
1120 Nineteenth St. N.W. Suite 310
Washington, DC 20036-3605
Phone: (202) 429-9280
Website: www.ime.org

SAFEX International is an industry group whose members manufacture civil or military explosives or technical grade ammonium nitrate (TGAN). TGAN is generally in the form of porous prills and is used in the manufacture of commercial explosives. SAFEX has published a guide for safe storage of TGAN listed below that is available to its members. https://www.safex-international.org/_index.php

Good Practice Guide: Storage of Solid Technical Grade Ammonium Nitrate. (March 2011). International Working Group on Ammonium Nitrate, SAFEX International. SAFEX Good Explosive Practice Series, GPG 02 rev. 1

STATUTES AND REGULATIONS

Statutes and regulations applicable to the manufacture of or processes involving AN, are listed below.

Clean Air Act Accident Prevention- General Duty (EPA)

Section 112(r) of the Clean Air Act (CAA) focuses on prevention of chemical accidents. Under this provision of the CAA, all facilities with regulated substances or other extremely hazardous substances have a general duty to prevent and mitigate accidental releases. Under Section 112(r)(1), the general duty is :

> to identify hazards …using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur.

This general duty applies to facilities producing, processing, handling or storing extremely hazardous substances. While not a regulated substance, AN may be considered extremely hazardous under certain circumstances.

Clean Air Act- Risk Management Program (EPA) and Process Safety Management (OSHA)

In 1990, amendments to the CAA authorized the EPA's Risk Management Program (RMP) Rule (40 CFR Part 68) under section 112(r), and required the Occupational Health and Safety Administration (OSHA) to issue the Process Safety Management Program (PSM) rule. Both rules serve to prevent chemical accidents. The RMP focuses on prevention and mitigation of accidental releases of listed toxic and flammable substances. Requirements under the RMP rule include development of a hazard assessment, a prevention program, and an emergency response program. While AN is not a listed substance subject to the RMP, chemicals used in the production of AN are included on the RMP list, making the process producing AN potentially subject to the RMP. Certain processes using AN may also involve RMP listed substances. For more information about RMP regulations, see http://www.epa.gov/emergencies/content/rmp/index.htm

OSHA's Process Safety Management (PSM) Standard establishes requirements intended to protect employees by preventing or minimizing the consequences of chemical accidents involving highly hazardous chemicals (29 CFR 1910.119). Although AN is not covered by the PSM standard, the production or use of AN may involve PSM listed chemicals in excess of thresholds. Manufacture of explosives, which may involve AN, is also covered by the PSM standard. For more information about OSHA's PSM standard see https://www.osha.gov/SLTC/processsafetymanagement/index.html

Emergency Planning and Community Right-to-Know Act (EPA)

The Emergency Planning and Community Right-to-Know Act (EPCRA), requires information on the presence of hazardous chemicals above designated threshold quantities at regulated facilities be provided to state and local emergency planning authorities. This information facilitates development of emergency response plans required by section 303 of EPCRA, enhances community awareness of

chemical hazards and help first responders to respond to chemical accidents. The chemicals covered under these requirements are a specific list of chemicals known as Extremely Hazardous Substances (EHSs) found at 40 CFR Part 355 Appendices A and B and any chemicals that meet the criteria as hazardous chemicals under OSHA's Hazard Communication Standard. AN is not an EHS but is considered a hazardous chemical (oxidizer) and therefore subject to the EPCRA provisions described below.

Section 311 of EPCRA requires facilities to submit Safety Data Sheets for the EHSs and hazardous chemicals to their State or Tribal Emergency Response Commission (SERC or TERC), Local Emergency Planning Committee (LEPC) and local fire department. Section 312 requires facilities to submit annually to their SERC or TERC, LEPC, and local fire department, Hazardous Chemical Inventory forms for these chemicals. The SDS provides the chemical's hazard information and emergency response guidelines and the Hazardous Chemical Inventory form provides the quantity, storage types and locations of the chemical at their facility. Regulations covering these requirements are found at 40 CFR Part 370.

Section 311(e)(5) of EPCRA does not include the following as a hazardous chemical: any substance used in routine agricultural operations or a fertilizer held for sale by a retailer to the ultimate customer. At fertilizer distributors, AN is commonly blended with other chemicals to produce a fertilizer mix according to customer specifications. Any AN that is mixed or formulated with other chemicals by facilities is not covered by the Section 311(e)(5) exemption. The exemption was intended to apply only to retailers of the substance, not to manufacturers and wholesalers – who typically have large quantities of fertilizers, and may use and manufacture a wide range of chemical compounds. These manufacturers and wholesalers can present significant risks that need to be addressed by emergency response authorities. For more information about EPCRA hazardous chemical reporting, see http://www.epa.gov/emergencies/content/epcra/index.htm

Environmental Protection Agency (EPA)
Phone: (800) 424-9346 or (703) 412-9810
Website: http://www.epa.gov

Explosives and Blasting Agents Standards (OSHA)

In addition to the PSM program described above, the Occupational Safety and Health Administration (OSHA) regulates the manufacture, keeping, having, storage, sale, transportation, and use of explosives and blasting agents under its Occupational Safety and Health Standards for explosives and blasting agents (29 CFR 1910.109). Blasting agents are frequently formulated with AN. For more information about OSHA's standards covering explosives and blasting agents, including ammonium nitrate and storage of all grades of ammonium nitrate, see https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9755&p_table=STANDARDS

Hazard Communication Standard (OSHA)

OSHA's Hazard Communication Standard (HCS) at 29 CFR 1910.1200 requires chemical manufacturers and importers to evaluate the hazards of the chemicals they produce or import, and prepare labels and Safety Data Sheets (SDS) to convey the hazard information to their downstream customers. All

employers with hazardous chemicals in their workplaces must have labels and safety data sheets for their exposed workers, and train them to handle the chemicals appropriately. AN is a hazardous chemical covered under the HCS. The HCS is now aligned with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Employers are required to train workers by December 1, 2013 on the new labels elements and safety data sheets format to facilitate recognition and understanding. For more information, see http://www.osha.gov/dsg/hazcom/index.html

Occupational Safety and Health Administration
Phone: (800) 321- OSHA (6742)
Website: http://www.osha.gov

Chemical Facility Anti-Terrorism Standards (DHS)

The Department of Homeland Security (DHS)'s Chemical Facility Anti-Terrorism Standards (CFATS) program applies to facilities that possess threshold quantities of certain types of ammonium nitrate. Facilities in possession of Chemicals of Interest (listed in 6 CFR Part 27 Appendix A) exceeding specific threshold quantities are required to complete a "Top-Screen" questionnaire to identify the types and quantities of Chemicals of Interest the facility possesses. For ammonium nitrate at any concentration (with more than 0.2% combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance) the Screening Threshold Quantity for risk of release is 5,000 pounds and for risk of theft is 400 pounds. This same form of ammonium nitrate is also classified by DOT as a Division 1.1 explosive. For solid ammonium nitrate, with a minimum concentration of 33% or greater and a nitrogen concentration of 23% nitrogen or greater, the Screening Threshold Quantity for risk of theft is 2,000 pounds. The CFATS program, first established under Section 550 of the 2007 DHS Appropriations Act, identifies and regulates high-risk chemical facilities to ensure they have security measures in place to reduce the risks associated with these chemicals. CFATS regulations are found in 6 CFR Part 27.

Based on the Top-Screen, if DHS initially determines the facility to be high-risk, the facility must complete and submit a Security Vulnerability Assessment, which is then reviewed by DHS to make a final determination on whether the facility is high-risk. Facilities receiving a final high-risk determination must develop and submit for DHS's review, a Site Security Plan (SSP), or alternatively, an Alternative Security Program, that describes the specific security measures the facility will utilize to meet the 18 applicable risk-based performance standards under CFATS. The agency must then conduct an inspection to help determine whether or not the facility's SSP should be approved. For more information about CFATS program, see http://www.dhs.gov/chemical-facility-anti-terrorism-standards

Hazardous Materials (DOT)

The Department of Transportation (DOT) regulates transportation of AN under its Hazardous Materials Regulations.

The following forms of ammonium nitrate are listing in the DOT Hazardous Materials Table (49 CFR 172.101) with their Hazard Class or Division:

Ammonium nitrate based fertilizer, 5.1
Ammonium nitrate based fertilizer, 9 (when transported by vessel or aircraft)
Ammonium nitrate emulsion or Ammonium nitrate suspension or Ammonium nitrate gel, intermediate for blasting explosives, 5.1
Ammonium nitrate-fuel oil mixture containing only prilled ammonium nitrate and fuel oil, 1.5D
Ammonium nitrate, liquid (hot concentrated solution), 5.1
Ammonium nitrate, with more than 0.2 percent combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance, 1.1D
Ammonium nitrate, with not more than 0.2% total combustible material, including any organic substance, calculated as carbon to the exclusion of any other added substance, 5.1

Explanation of Hazard Class numbers:
1.1 - Explosives (with a mass explosion hazard) A mass explosion is one which affects almost the entire load instantaneously.
1.5 - Very insensitive explosives; blasting agents
5.1 - Oxidizer
9 - Miscellaneous Hazard Material

DOT also requires security plans for persons offering for transportation or transporting any quantity of a Division 1.1 or 1.5 material containing ammonium nitrate or large bulk quantities (greater than 6,614 lbs or 792 gals) of ammonium nitrate, ammonium nitrate fertilizers, or ammonium nitrate emulsions, suspensions, or gels. The security plan must conform to requirements in 49 CFR 172.800.

Department of Transportation
Phone: (202) 366-5580 - Public Information
Website: http://www.dot.gov

Explosives Regulations (ATF)

The Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) of the Department of the Justice regulates the importation, manufacture, distribution, and storage of explosive materials including blasting agents and other explosive materials containing AN. ATF's explosives regulations, 27 CFR Part 555, can be located at http://www.atf.gov/regulations-rulings/regulations/index.html

Bureau of Alcohol, Tobacco, Firearms, and Explosives
Phone: (202) 648-7120
Website: http://atf.gov

For More Information, Contact:

The Superfund, TRI, EPCRA, Risk Management Program, and Oil Information Center
(800) 424-9346 or (703) 412-9810
TDD (800) 553-7672 or (703) 412-3323