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Agency

Office of Solid Waste
and Emergency Response
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www.epa.gov

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EXPLOSION HAZARD FROM AMMONIUM NITRATE

The Environmental Protection Agency (EPA) is issuing this *Alert* as part of its ongoing effort to protect human health and the environment. EPA is striving to learn the causes and contributing factors associated with chemical accidents and to prevent their recurrence. Major chemical accidents cannot be prevented solely through command and control regulatory requirements but by understanding the fundamental root causes, widely disseminating the lessons learned, and integrating these lessons learned into safe operations. EPA will publish Alerts to increase awareness of possible hazards. It is important that facilities, SERCs, LEPCs, emergency responders and others review this information and take appropriate steps to minimize risk.

CHEMICAL SAFETY ALERT

PROBLEM

Ammonium nitrate primarily is used as a fertilizer; it also is used widely with additives as a blasting agent. Millions of tons of this chemical are produced annually throughout the world and handled without incident. According to scientific literature, ammonium nitrate is a strong oxidizer and a relatively stable explosive. For the purpose of transportation, ammonium nitrate with less than 0.2 percent combustible substances and ammonium nitrate fertilizers are classified by the U.S. Department of Transportation as oxidizers. Ammonium nitrate with more than 0.2 percent combustible substances is classified as an explosive. Ammonium nitrate can be exploded under certain conditions. These must include added energy (heat, shock), especially under conditions of confinement or presence of contaminants. Although ammonium nitrate generally is used safely and normally is stable and unlikely to explode accidentally, accidental explosions of ammonium nitrate have resulted in loss of lives and destruction of property. These accidents rarely occur, but when they do, they have high impacts. Many of the safe handling procedures were developed after learning from these accidents.

ACCIDENTS

In a 1994 accident , ammonium nitrate solution exploded during a manufacturing process, causing a number of deaths and injuries. In this process, ammonia and nitric acid were reacted in a neutralizer vessel to produce 83 percent ammonium nitrate solution for use in fertilizer. At the time of the accident, the neutralizer contained approximately 164,000 pounds of ammonium nitrate. During a procedure to shut down the process, compressed air was applied to the nitric acid line into the neutralizer, followed by pressurized steam at 200 pounds per square inch gauge (psig) and temperatures up to 430°F. After the steam had passed through the nitric acid line for several hours, the ammonium nitrate exploded in the neutralizer. EPA believes localized areas of the ammonium nitrate solution were heated to high temperatures by the steam. The compressed air and steam created bubbles in the solution. The solution was highly acidic and was contaminated by chlorides. EPA believes the acidic conditions, bubbles, localized high temperatures, and chloride contamination contributed to the explosion.

Another explosion occurred in 1989, during the manufacture of ammonium nitrate by a high temperature process. In this case, upset conditions allowed prolonged exposure of ammonium nitrate to temperatures up to 500°F under high pressure and low pH (acidic).

Other past accidental explosions of ammonium nitrate have included some of the most destructive on record. Several of these, including two in Germany in 1921, occurred during attempts to break up large piles of solidified or caked ammonium nitrate-ammonium sulfate mixtures using a blasting explosive. The blasting initiated explosions in the ammonium nitrate-ammonium sulfate mixtures. Other large explosions were triggered by fires involving ammonium nitrate in confined spaces, including the 1947 explosion of two cargo ships. A fire in the hold, involving ammonium nitrate fertilizer coated with wax and stored in paper bags, caused the explosion of the first ship; the ammonium nitrate in the second ship exploded some time later, apparently as a result of a fire caused by the first explosion. As a result of such accidents and subsequent studies of the properties of ammonium nitrate, caked ammonium nitrate no longer is broken up with blasting agents, and wax coatings are no longer used for ammonium nitrate fertilizer.

Explosions of ammonium nitrate, involving relatively small quantities, have occurred during the preparation of nitrous oxide. In these cases (e.g., an explosion in 1977), the explosions of ammonium nitrate occurred as a result of excessively high temperatures and confinement during processing.

Two explosions of ammonium nitrate solutions that occurred during processing at ordnance plants during the Second World War were believed to be caused by the explosion of a small amount of ammonium nitrate in a blocked pipe, which then initiated the explosion of a larger quantity of solution.

Hazard Awareness

Ammonium nitrate, in solid or molten form or in solution, is a stable compound and generally is difficult to explode. Ammonium nitrate may explode, however, when exposed to strong shock or to high temperature under confinement. In a large quantity of ammonium nitrate, localized areas of high temperature may be sufficiently confined by the total quantity to initiate an explosion. The explosion of a small quantity of ammonium nitrate in a confined space (e.g., a pipe) may initiate the explosion of larger quantities (e.g., in an associated vessel).

Contaminants may increase the explosion hazard of ammonium nitrate. Organic materials generally will make ammonium nitrate explosions more energetic. Ammonium nitrate may be sensitized by certain inorganic contaminants, including chlorides and some metals, such as chromium, copper, cobalt, and nickel. As ammonium nitrate solution becomes more acidic, its stability decreases, and it may be more likely to explode.

Low density areas, such as bubbles, in molten ammonium nitrate or solutions, also may increase the possibility of an explosion and enhance the propagation of an explosion.

Ammonium nitrate by itself does not burn, but in contact with other combustible materials, it increases the fire hazard. It can support and intensify a fire even in the absence of air. Fires involving ammonium nitrate can release toxic nitrogen oxides and ammonia. A fire involving ammonium nitrate in an enclosed space could lead to an explosion. Closed containers may rupture violently when heated.

Process Safety Areas for Hazard Reduction

Facilities should be aware of the hazards of ammonium nitrate and ensure that the conditions that may lead to an explosion are not present. Actions that may help to prevent explosions include:

- Avoid heating ammonium nitrate in a confined space (e.g., processes involving ammonium nitrate should be designed to avoid this possibility).

- Avoid localized heating of ammonium nitrate, potentially leading to development of high temperature areas.
- Ensure that ammonium nitrate is not exposed to strong shock waves from explosives.
- Avoid contamination of ammonium nitrate with combustible materials or organic substances such as oils and waxes.
- Avoid contamination of ammonium nitrate with inorganic materials that may contribute to its sensitivity to explosion, including chlorides and some metals, such as chromium, copper, cobalt, and nickel.
- Maintain the pH of ammonium nitrate solutions within the safe operating range of the process. In particular, avoid low pH (acidic) conditions.

INFORMATION RESOURCES

Some references that contain information about the hazards of ammonium nitrate and methods of minimizing these hazards are listed below. Regulations applicable to the manufacture of or processes involving ammonium nitrate, and codes and standards that may be relevant, are also listed.

General References

The following references and organizations provide information on ammonium nitrate and its hazards.

Sax's Dangerous Properties of Industrial Materials, Ninth Edition. New York: Van Nostrand Reinhold (1996).

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Kirk-Othmer Encyclopedia of Chemical Technology, Fourth Edition, Volume 2. New York: John Wiley & Sons (1992).

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The National Fire Protection Association (NFPA) includes information on ammonium nitrate in its publication NFPA 49— Hazardous Chemicals Data, 1994. This publication provides guidance on hazardous chemicals to emergency personnel and others.

National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Phone: (617) 770-3000
Web site: http://www.nfpa.org

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The National Safety Council has a data sheet titled "Ammonium Nitrate Fertilizer, Data Sheet I-699, Rev. 91" that discusses the health hazards, properties, and precautions for safe storage and handling of ammonium nitrate fertilizer.

National Safety Council
1121 Spring Lake Drive
Itasca, IL 60143-3201
Phone: (630) 285-1121
Web site: http://www.nsc.org

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The Fertilizer Institute possesses information on various fertilizer products, including ammonium nitrate, and their uses.

The Fertilizer Institute
501 Second Street, NE
Washington, DC 20002
Phone: (202) 675-8250

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Statutes and Regulations

Section 112(r) of the Clean Air Act focuses on prevention of chemical accidents. It imposes on facilities with regulated substances or other extremely hazardous substances a general duty to prevent and mitigate accidental releases. This general duty would apply to hazards associated with ammonium nitrate. Accident prevention activities include identifying hazards and operating a safe facility.

EPA's Risk Management Program (RMP) Rule (40 CFR 68) is intended to prevent and mitigate 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 ammonium nitrate is not a 112(r) listed substance, chemicals used in the production of ammonium nitrate are included on the 112(r) list. Certain processes using ammonium nitrate may also involve listed substances.

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The Department of Transportation (DOT) regulates transportation of ammonium nitrate under its Hazardous Materials Regulations. Ammonium nitrate is listed in DOT's Hazardous Materials Table (49 CFR 172.101).

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

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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 ammonium nitrate.

OSHA's Process Safety Management Standard establishes procedures intended to protect employees by preventing or minimizing the consequences of chemical accidents involving highly hazardous chemicals (29 CFR 1910.119). Although ammonium nitrate is not covered by the PSM standard, the production or use of ammonium nitrate may involve listed chemicals in excess of thresholds. Manufacture of explosives, which may involve ammonium nitrate, also is covered by the PSM standard.

Occupational Safety and Health Administration
Phone: (202) 219-8151 - Public Information
Web site: http://www.osha.gov

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The Bureau of Alcohol, Tobacco, and Firearms of the Department of the Treasury regulates the importation, manufacture, distribution, and storage of explosive materials (27 CFR 55), including blasting agents and other explosives containing ammonium nitrate.

Bureau of Alcohol, Tobacco, and Firearms
Phone: (202) 927-7777
Web site: http://atf.treas.gov

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Codes and Standards

NFPA has developed a code for storage of ammonium nitrate, including mixtures containing 60 percent or more by weight of ammonium nitrate, and a code for explosives that would apply to blasting agents and explosives containing ammonium nitrate. These codes, which may be adopted into law at the state or local level, are:

NFPA 490 — Storage of Ammonium Nitrate, 1993, and
NFPA 495 — Explosive Materials Code, 1996.

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Accident Investigation Report

EPA investigated the ammonium nitrate explosion that occurred in 1994 and developed the following report:
United States Environmental Protection Agency, Region 7, Emergency Response and Removal Branch, Kansas City, KS, Chemical Accident Investigation Report — Terra Industries, Inc., Nitrogen Fertilizer Facility, Port Neal, Iowa

FOR MORE INFORMATION...

CONTACT THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW HOTLINE

(800) 424-9346 OR (703) 412-9810
TDD (800) 553-7672

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