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<https://www.wsj.com/articles/what-is-ammonium-nitrate-the-chemical-behind-the-beirut-explosion-11596658988>

WORLD | MIDDLE EAST

What Is Ammonium Nitrate, the Chemical Behind the Beirut Explosion?

Widely used in farming as fertilizer, the substance has caused some of the world's deadliest blasts outside wartime



Ammonium nitrate is a chemical compound that farmers normally spread as small pellets that dissolve in the soil and fertilize it.

PHOTO: STEPHANE MAHE/REUTERS

By [David Gauthier-Villars](#)

Aug. 5, 2020 4:23 pm ET

The explosion that ripped through Beirut on Tuesday was likely caused by a fire that detonated an estimated 2,750 metric tons of ammonium nitrate, killing at least 100 people and injuring thousands more. Lebanese authorities said it had been kept at a warehouse in the city's port for more than six years. The blast produced a shockwave that shattered windows and caused massive damage along the densely populated historic waterfront.

What is ammonium nitrate?

Ammonium nitrate is a chemical compound widely used in farming as fertilizer. It

is normally spread as small pellets and dissolves quickly in moisture, releasing nitrogen into the soil.

How dangerous is ammonium nitrate?

Under normal conditions it is safe. “Ammonium nitrate normally sits nicely and behaves itself until you do something catastrophic to it,” said Jimmie Oxley, a professor of chemistry at the University of Rhode Island.

Fire, Blast and Shockwave

How ammonium nitrate stored in Beirut's port caused chaos through the city

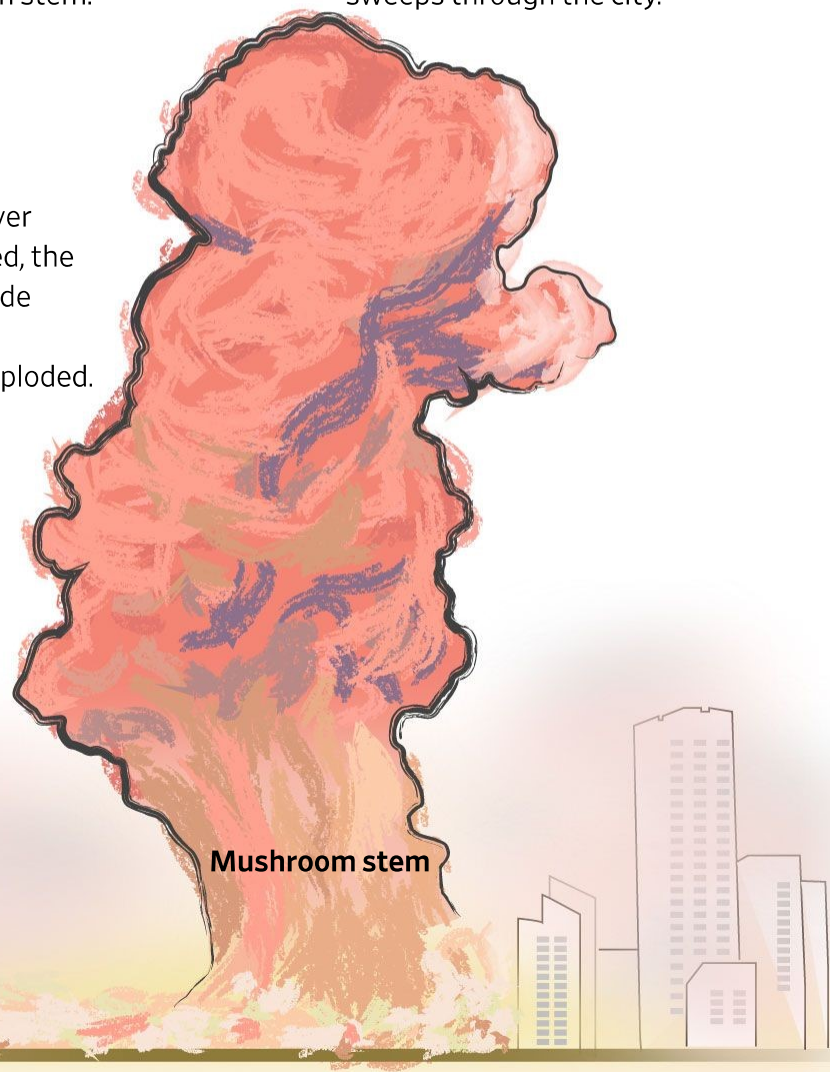
- 1 A fire breaks out at a port warehouse storing ammonium nitrate.



- 3 A second explosion triggers a ball of fire. The fireball rises, pulling air, water vapor and debris into the mushroom stem.

- 4 A white, dome-shaped shockwave shatters windows and damages buildings as it sweeps through the city.

- 5 The cloud billowing over Beirut is brown and red, the color of nitrogen dioxide released when the ammonium nitrate exploded.



Sources: Cheryl Rofer, Los Alamos National Laboratory (retired); Jeffrey Lewis, Middlebury Institute; Vipin Narang, Massachusetts Institute of Technology; Andrea Sella, University College London
Roque Ruiz/THE WALL STREET JOURNAL

What went wrong in Beirut

When pellets of ammonium nitrate are stored for a long period of time, they tend to absorb moisture, aggregating into rock-like blocks and becoming more sensitive to shocks, according to Andrea Sella, a professor of chemistry at UCL, a university in London. Lebanese authorities believe a fire set off the explosions. The first, which came with a lower boom, corresponded to a deflagration, or subsonic reaction, according to Prof. Sella. The second, much bigger blast that followed, was a detonation, characterized by a supersonic process.

Why did it create a dome-shaped cloud over Beirut?

The cloud traveling outward, which was captured by Beirut residents with their cell phones, was the shockwave produced by the second explosion, according to Prof. Sella.

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June 9, 2020 August 5, 2020

Maxar Technologies

Was it a bomb?

No. But ammonium nitrate is used to make explosives for the mining industry. Terrorists have seized on its devastating potential, too, most notably in 1995, when two American men used two tons of ammonium nitrate to destroy a U.S. federal building in Oklahoma City, killing 168 people.

Why was the ammonium nitrate stored at the Beirut port?

The ammonium nitrate entered the Beirut port in 2013 on board a ship that was later abandoned by its owner, according to Lebanese officials. The cargo was transferred to a warehouse where it remained stored until Tuesday's explosion.

What is the concrete structure still standing in the Beirut port?

It is what remains of the city's grain silos. They may have acted as a screen, protecting buildings behind them from the devastating impact of the blast, according to Prof. Sella.

Has anything like the Beirut explosion happened before?

Yes. When combined with fuel oils or exposed to high temperatures, ammonium nitrate can be explosive and has caused a series of devastating accidents. Here are some notable disasters involving the compound:

Deadly Chemical

Used primarily as a fertilizer in agriculture, ammonium nitrate can turn into a powerful explosive under certain conditions and was behind a series of catastrophes

Ammonium nitrate disasters

Germany, 1921

4,500 metric tons ammonium nitrate

France, 1947

3,000

Lebanon, 2020

2,750

U.S., 1947

2,000

China, 2015

800

France, 2001

300

U.S., 2001

30

Sources: Old Facts Revisited, by Ulrich Hörcher, Chemical Engineering Transactions vol. 48, 2016 (Germany); L’Ocean Liberty Explode en Rade de Brest, by Jean-Yves Brouard, 2007 (France, 1947); Lebanese government (Lebanon); Jimmie Oxley, University of Rhode Island (U.S.); U.K. National Chemical Emergency Centre (China); France’s National Assembly (France, 2001)

1921—Germany

A silo containing 4,500 metric tons of ammonium nitrate and other compounds exploded at a plant operated by chemicals giant BASF in Oppau, an industrial town in western Germany. The explosion took place when workers used dynamite to break up ammonium nitrate that was caked together, a common practice at the time, according to Prof. Oxley. The blast, which was heard in Munich, some 125 miles away, left more than 500 people dead.

1947—U.S.

A French ship docked in Texas’s Galveston Bay and loaded with more than 2,000 metric tons of ammonium nitrate caught fire, resulting in a powerful blast that led to a chain of other explosions in the area, killing at least 581 people and leaving dozens unaccounted for. At the time, the U.S. was shipping vast amounts of

ammonium nitrate to Europe to support the resumption of agriculture on the war-ravaged continent. That same year, a fire on board a ship that had called in the French port of Brest detonated its cargo of more than 3,000 tons of ammonium nitrate.

2001—France

An explosion occurred in a warehouse storing some 300 metric tons of ammonium nitrate in the southern French city of Toulouse. The site, which belonged to French oil company Total, was flattened. Thousands of houses and dozens of factories were destroyed and 31 people died.

2013—U.S.

The small town of West in Texas was rocked by the explosion of 30 metric tons of ammonium nitrate at a fertilizer distribution company. The blast killed 15 people, including 12 first responders who had rushed to the site to help contain a fire at the facility.

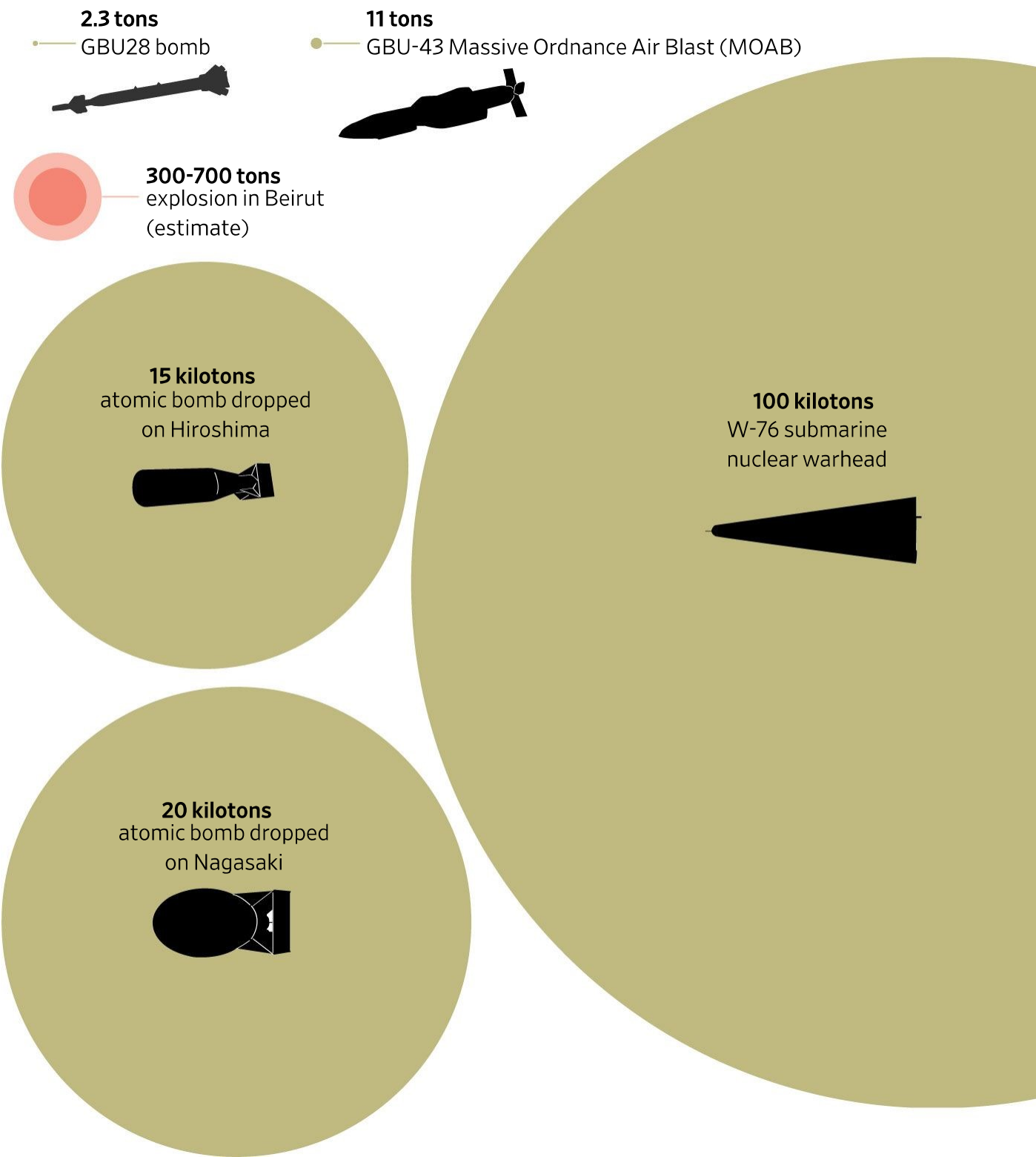
2015—China

A series of explosions occurred at the port of Tianjin. One of the largest blasts was at a warehouse storing about 800 metric tons of ammonium nitrate. Nearly two-thirds of the more than 170 fatalities were firefighters.

Blast Power

Arms-control experts estimate the size of the Beirut explosion was larger than some common bombs used in airstrikes, but smaller than WWII atomic weapons.

Strength of explosions, equivalency in TNT



Sources: Jeffrey Lewis, Middlebury Insitute (TNT equivalents); U.S. Air Force (GBU-28, MOAB, Hiroshima, Nagasaki); Federation of American Scientists (W-76)