

What we know about the massive chemical explosion in Beirut

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- The red-orange cloud rising above the site of the explosion in Beirut on August 4 is due to nitrogen dioxide, a byproduct of the explosion of ammonium nitrate.
- A satellite image of Beirut's port, taken on June 9, 2020.
- A satellite image of Beirut's port taken on August 5, 2020, showing the devastation to the area.
- Very little remains standing in the port area following the huge explosion.
- This is a closeup satellite image of the grain silos, taken on June 9, 2020. These held up to 85 percent of the country's grain stocks.
- The silos are still upright following the explosion, but the grain inside has been destroyed.
- An oblique satellite view of the silos post-explosion.
- All that remains of the grain silo, as seen from the ground. The orange tinge is likely due to staining by nitrogen dioxide, a byproduct of the reaction that destroyed the port.
- The *Orient Queen* passenger ship in Beirut's port as seen

from a satellite on July 31.

- The *Orient Queen* was capsized by the blast.
- An oblique view of the capsized *Orient Queen*.
- Beyond the port area, there was widespread damage to buildings.
- A satellite view of Beirut's central district after the explosion.
- 300,000 people have been made homeless according to the Governor of Beirut.
- Debris litters the floor of the Lebanese Parliament hemicycle in the central district of the capital Beirut, on August 5, 2020, in the aftermath of the explosion.
- Another satellite view of damage to Beirut following the explosion of 2,750 tons of ammonium nitrate.
- Vehicles were destroyed by the shockwave.
- An overview of Beirut taken from a satellite on August 5, 2020.

On Tuesday, Beirut was devastated by a massive chemical explosion that occurred at the city's port a little after 6pm local time. The blast killed at least 135 people and injured thousands more, and it may have left 300,000 residents homeless after the shockwave shattered glass and damaged buildings across the Mediterranean city. Initial reports blamed improperly stored fireworks for the disaster, but the real culprit soon emerged: 2,750 tons of ammonium nitrate (NH_4NO_3) that had been seized by Lebanese officials from a freighter in 2013 and stored at a warehouse at the port ever since.

It's now believed that a fire broke out at the warehouse—possibly due to careless welding performed as an anti-theft measure—which caused the stockpile of the chemical, often used as a fertilizer, to explode catastrophically.

Ammonium nitrate has often been combined with fuel oil to create an explosive that's used in mining and construction, and it has been used as an oxidizer for rocket engines. But

it's also been employed for more nefarious ends. The first recorded ammonium nitrate fuel oil (ANFO) bomb was detonated in 1970 at the University of Wisconsin-Madison as a protest against the Vietnam War. Terror groups on both sides of Northern Ireland's sectarian conflict also built bombs using ANFO from the 1970s until the 1990s, and Timothy McVeigh used a combination of ammonium nitrate and nitromethane for a terror attack in Oklahoma City in 1995.

Dangerous stuff

But industrial accidents involving ammonium nitrate have been responsible for even greater disasters. When the chemical is subjected to enough heat, it decomposes either to form nitrous oxide (N_2O) and water or, at higher temperatures, nitrogen (N_2), oxygen (O_2), and water; in both cases, the result is a highly exothermic, energetic reaction. One clue to the role of ammonium nitrate in this explosion was the deep red-orange color of the blast that could be seen in the many videos posted online; this was caused by the presence of highly toxic nitrogen dioxide gas, which is formed as a secondary product of the reaction.

In 1947, a fire broke out aboard a cargo ship in the port of Texas City, Texas, that was carrying 2,300 tons of ammonium nitrate. An ill-advised decision to pipe steam into the confines of the ship in an attempt to fight the fire contributed to a massive blast that killed at least 567 people in an event that is often referred to as the worst industrial disaster in American history (the explosion also ignited another 961 tons of ammonium nitrate and 1,800 tons of sulfur on another ship). More recently, in 2013 the city of West, Texas, was rocked by an explosion at a fertilizer plant that was improperly storing more than 270 tons of the chemical, killing 15 and injuring up to 200 more. And in 2015, 881 tons of ammonium nitrate was detonated by a nitrocellulose fire at the Port of Tianjin in China, killing 165.

Much smaller than a nuclear explosion

Estimates for the yield of the explosion in Beirut have varied. Under ideal conditions, a ton of ammonium nitrate has an explosive force equivalent to about 0.45 tons of TNT. But in Beirut, this stockpile was stored in an open factory and had been sitting around for seven years.

One estimate puts it at the equivalent of 240 tons of TNT, based on map data and the amount of overpressure required to cause the damage seen. Another analysis that measured the size of the explosion's fireball suggests a similar-sized blast at about 300 tons of TNT. At the upper end, another analysis that factored in the size of the explosion and air density came up an equivalent of 3 kilotons of TNT.

For context, the atom bomb dropped on Hiroshima 75 years ago had a yield of about 15 kilotons. And the largest human-made non-nuclear explosion on record was a 1917 disaster in Halifax, Canada, which occurred when a munitions ship caught fire before exploding with a force of approximately 2.9 kilotons. Since the Halifax explosion destroyed everything within a half-mile (800m) radius, the lower estimates for the Beirut explosion appear to be more reasonable. What we do know with some precision is that a seismic shock with a magnitude of 3.3 was measured at the time of the blast.

Satellite images comparing the area before and after the explosion show the complete destruction of Beirut's port. The grain silos that were next to the site of the explosion are still partially upright, although it's believed that up to 85 percent of the country's grain stocks have been lost. (Lebanon imports 80 percent of its food supply, and Beirut normally handles 60 percent of the country's total imports.)

Little else remains in the area other than rubble; across the

port from the site of the explosion is a capsized passenger ship. Windows were shattered up to two miles away, and together with other damage to buildings, up to 300,000 people have been made homeless, according to the governor of Beirut.

You can find ways to help Beirut's relief efforts [here](#).

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