



# Herrig Brothers Propane Tank Explosion

Albert City, Iowa April 9, 1998

On April 9, 1998, two volunteer firefighters were killed and seven other people were injured when a blazing 18,000-gallon propane tank exploded at the Herrig Brothers poultry farm in Albert City, Iowa. Arriving at 11:21 p.m., the firefighters had found the large storage tank engulfed in flames hundreds of feet high. The noise of gas escaping the tank through pressure relief valves was “like standing next to a jet plane with its engines at full throttle,” a witness said. Minutes later the victims were struck by heavy metal fragments when the tank exploded.

The propane tank fire started after two teenagers driving an all-terrain vehicle (ATV) plowed into unprotected propane piping at the farm. This aboveground piping ran from the propane storage tank to vaporizers, which fueled heaters located in barns and other farm structures. The 42-foot long, cigar-shaped storage tank contained propane liquid and vapor under pressure, and the tank was about half full at the time of the incident.

The collision severed one pipe and damaged another, triggering a significant propane leak under the tank. About five



Herrig Tank before Explosion

minutes later, propane vapor leaking from the damaged pipes ignited and burst into flames, engulfing the tank and beginning to heat the propane inside.

Because of the flames, arriving firefighters could not approach a manual shut-off valve to stop the propane leak, and they decided to let the tank fire burn itself out. The fire chief on the scene believed that in the event of an explosion, fragments would be thrown from the tank’s two dome-shaped welded ends. The areas near the sides of the tank, he believed, would be relatively safe. Shortly after their arrival, firefighters approached the sides of the flaming tank

and began spraying the surrounding buildings to prevent the spread of fire.

Just seven minutes later, the burning



Damaged Property at Herrig Bros. Farm

propane tank ruptured completely, experiencing a Boiling Liquid Expanding Vapor Explosion or BLEVE.

The propane tank was blown into at least 36 pieces, some of which flew 100 feet or more. Some of the shrapnel struck firefighters; other pieces smashed into buildings, leaving nearly \$250,000 in property damage.

The U.S. Chemical Safety Board investigated this incident to determine root causes of the fire, the explosion, and the firefighter fatalities and injuries.

## PROPANE TANK AND PIPING LACKED COLLISION PROTECTION

The CSB found the initial fire likely could have been avoided by protecting the aboveground propane piping from a motor vehicle collision. Had a fence or barrier been in place, the ATV driver likely would not have collided with the propane piping and no leak or fire would have occurred. Although propane delivery trucks came frequently to the farm — driving into close proximity of the storage tank and the aboveground piping — neither the tank nor the piping was protected by any fences, barriers, or posted warning signs.

Despite a requirement of Iowa state law, the Iowa State Fire Marshal evidently had not received any information about the propane system installed at Herrig Brothers. The CSB found that neither the farm owners nor the propane installers appeared to believe it was their responsibility to provide construction plans to the marshal. Had the marshal’s office reviewed the plans and required a protective barrier around the aboveground pipes, the collision and fire would likely have been prevented.

## WHAT IS A BLEVE?

A Boiling Liquid Expanding Vapor Explosion or BLEVE (pronounced “BLEV-ee”) can occur when fire heats and weakens the walls of a storage tank, particularly in the region above the stored liquid where cooling is less effective. At some point the weakened tank can no longer withstand the internal pressure and the tank fails catastrophically, often sending fragments in many directions.

## FLAWED DESIGN OF PROPANE SYSTEM

The propane piping was equipped with a safety feature designed to prevent a major leak. An “excess flow” valve installed on the tank was designed to close if the propane

flow in the piping exceeded about 200 gallons per minute — the kind of massive flow that would be expected with a complete breakage of the pipe. However, the piping installed immediately downstream of the excess flow valve was too narrow to allow the flow rate to ever reach 200 gallons per minute, even with piping completely severed further downstream.

The excess flow valve never closed and the propane leak continued unabated, feeding the fire until the time of the explosion.

This design flaw came to light in specialized testing commissioned by the CSB and performed by NASA. Had the downstream piping been large enough, the excess flow valve would have closed after the ATV collision, arresting the flow of propane and greatly reducing the severity of any fire. Most likely, no explosion would have occurred.

#### BETTER TRAINING COULD HAVE SAVED FIREFIGHTERS

The CSB determined that better training could have prevented the firefighter deaths and injuries. The firefighters were not prepared for the dangers of a BLEVE, where tank debris can fly in any direction, not just from the ends. Unaware of the danger, they had positioned themselves too close to the sides of the burning tank.

Nearly all Albert City firefighters had viewed a safety training video produced by the National Propane Gas Association (NPGA). The video recommended that firefighters approach a burning propane tank from the sides, and the accompanying training manual explained that pieces from a ruptured tank “can and will, most likely, travel in the direction it is pointed” i.e. along the long axis of the tank. In this incident, the Albert City Fire Chief reported that he relied on NPGA and other similar training guidelines and believed that avoiding the ends of the burning tank would protect the firefighters.

The firefighters also likely did not realize just how quickly a BLEVE can take place, typically within 10-30 minutes of the start of a fire. The firefighters had arrived about 15 minutes after the tank ignited, and the explosion occurred just seven minutes later. The speed with which these explosions can occur is an important consideration in deciding how to respond to a propane tank fire, the CSB said. When a boiling liquid expanding vapor explosion is

possible, the best emergency response may be to retreat to a safe distance and rely on unmanned firefighting equipment.

#### KEY RECOMMENDATIONS

After analyzing the root causes of the Herrig Brothers incident, the CSB on June 23, 1999, made a number of recommendations to improve future safety.

##### To the Iowa State Fire Marshal:

The Board called on the marshal to ensure full implementation of the National Fire Protection Association’s standard on propane handling and storage, known as NFPA-58. In particular, the marshal should designate a specific party to be responsible for submitting propane construction plans and should provide appropriate procedures for plan approval, equipment permitting, and inspection.

##### To the National Propane Gas Association (NPGA):

The Board recommended that the NPGA revise its videos, manuals, and other training materials to provide appropriate instruction on responding to potential tank BLEVEs. A similar recommendation was directed to the Fire Service Institute of Iowa State University.

##### To the Herrig Brothers Farm:

The Board requested that the farm install fencing or barriers to protect aboveground propane pipes from vehicular damage. The Board also recommended that the design defect identified in the propane distribution system — the mismatch between the size of the excess flow valve and the downstream piping — be corrected.

#### HERRIG INVESTIGATION CAUSES D.O.T. GUIDEBOOK IMPROVEMENT

CSB’s Herrig investigation also uncovered a potentially misleading statement in the U.S. Department of Transportation’s *North American Emergency Response Guidebook*. The *Guidebook* is carried in thousands of fire trucks around the country, and firefighters often consult this reference when responding to hazardous material incidents. The 1996 version of the *Guidebook* stated that responders should “*always stay away from the ends of tanks*” when fighting flammable liquid tank fires. This advice could give the false impression that the sides of the tank are safe in such cases. On the advice of the Board, DOT revised the year 2000 *Guidebook*, which now counsels firefighters who face propane fires to “*always stay away from tanks engulfed in fire.*”

#### NOTICE:

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