



RESEARCH

**NATURAL GAS AND PROPANE FIRES, EXPLOSIONS AND LEAKS
ESTIMATES AND INCIDENT DESCRIPTIONS**

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Natural Gas and Propane Fires, Explosions and Leaks Estimates and Incident Descriptions

An estimated average of 4,200 home structure fires per year started with the ignition of natural gas. These fires caused an average of 40 deaths per year. The statistics, incident descriptions from NFPA publications and reports from the National Transportation Safety Board (NTSB) show that most major gas incidents involved some type of leak.

In the U.S., local fire departments respond to an average of 340 natural gas or LP-Gas leaks per day with no ignition. Although gas leaks are much more common than gas ignitions, they can be precursors to devastating events.

Gas Leaks in or on Home Properties Reported to Local Fire Departments

Local fire departments responded to an average of 125,000 natural gas or LP-Gas leaks per year that did not result in fires in or at home properties in 2012-2016. Since 2007, these incidents have generally been increasing. The National Fire Incident Reporting System (NFIRS), the source of details about fires and other incidents, does not specifically identify which gas leaked or where it leaked from. Some portion of these leaks were probably from gas grills or cylinders rather than gas distribution systems. Unfortunately, these cannot be separated or quantified.

Home Structure Fires that Began with the Ignition of Natural Gas: 2012-2016

Leaks or breaks were the leading factors contributing to home structure fires per year that began with the ignition of natural gas. Cooking equipment was involved in 54% of the natural gas fires, and heating equipment, including water heaters, was involved in 25%. No clear trend was seen for these fires.

Descriptions of Natural Gas and Propane Fires and Explosions from NFPA Publications

These incident descriptions from *NFPA Journal's* Firewatch column and reports from the Research, Data and Analytics Division show what *can* happen in these incidents, and something about fire department activities at these incidents. These incidents show what *can* happen; they should not be considered typical or statistically representative. Most of these incidents involved fatalities after an ignition of, or explosion involving, leaked gas.

Synopses of NTSB Reports on Natural Gas and Propane Pipeline Incidents Involving Homes

The NTSB performs in-depth investigations of major transportation incidents, including gas pipeline incidents. Their exhaustive investigation includes details on the materials used, installation process, pre-incident conditions, how any leak occurred, relevant regulations, practices and actions taken during the event by all consumers, utilities, first responders, and the event aftermath.

In some cases, problems had been reported and the utility was investigating before an explosion. In others, consumers had smelled gas but not reported it. In some cases, there were problems with the pipe installation. In others, pipes had been damaged.

Gas Leaks in or on Home Properties Reported to Local Fire Departments

Between the years of 2012 and 2016 local fire departments responded to an estimated 125,000 gas leaks (natural gas or LPG), in or on home properties per year. (This number also excludes gas odors with no source found). Home properties include one- and two-family homes, including manufactured homes, and apartments and other multi-family housing.

There is no further detail on the type of gas (natural vs. LPG) that was detected or from where the leak came. Leaks could come from gas line piping, from grills or grill cylinders, or other sources. Over the past decade there seems to be an upward trend in these types of incidents.

Gas Leaks in Home Properties by Year

Year	Gas Leak Incidents in Home Properties
2007	100,000
2008	103,500
2009	105,500
2010	111,000
2011	106,000
2012	105,500
2013	109,000
2014	125,500
2015	143,500
2016	141,000
2012-2016 annual average	125,000

Information is based on National Fire Incident Reporting System and NFPA's Annual Fire Experience Survey. Incidents are NFIRS Incident Type Code 412 - Gas leak (natural gas or LPG). Excludes gas odors with no source found (671).

Home Structure Fires that Began with the Ignition of Natural Gas: 2012-2016

Local fire departments responded to an estimated average of 4,200 U.S. home structure fires per year that started with the ignition of natural gas. These fires caused an average of 40 civilian deaths, 140 civilian injuries, and \$54 million in direct property damage per year.

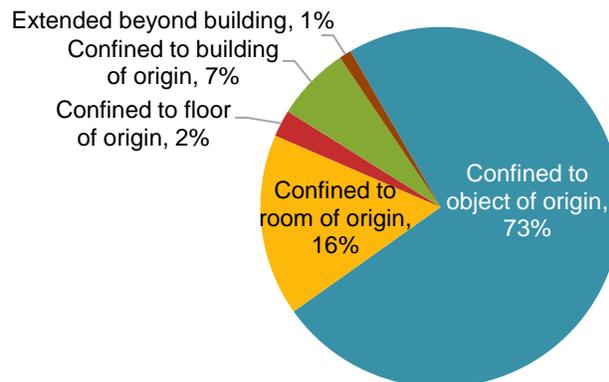
Homes include 1- or 2- family homes, including manufactured housing, and apartments or other multi-family housing.

Leaks or breaks were factors in 20% of the fires and 54% of the deaths. Other types of mechanical failures or malfunctions, including worn out parts, failures of controls, and unclassified mechanical failures or malfunctions, were factors in 27% of the fires and 3% of the deaths.

Some type of operating equipment ignited the natural gas in 58% of these fires and 32% of the deaths. Although cooking equipment was involved in 54% of the fires, it was involved in only 10% of the deaths. Heating equipment was the heat source in 35% of the fires and 41% of the deaths. The leading types of heating equipment involved in these deaths were water heaters, fixed or portable space heaters, and central heat.

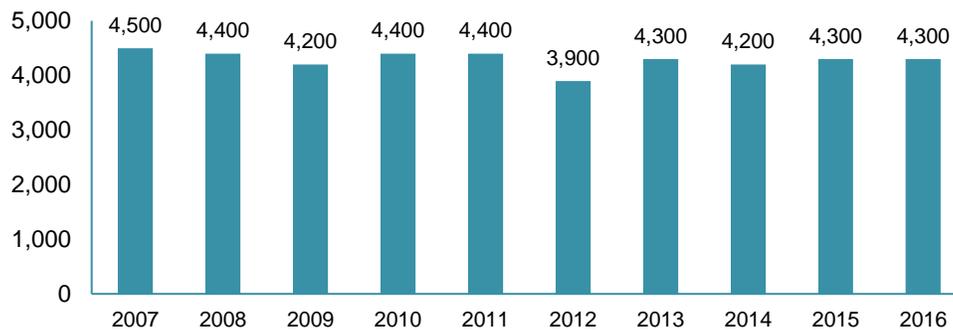
In almost three-quarters (73%) of the natural gas ignitions, the fire was confined to the object of origin.

Extent of Fire Spread in Home Gas Fires: 2012-2016



Estimates of home natural gas fires have generally hovered between 4,200 and 4,500 from 2007 through 2016.

Home Natural Gas Fires by Year



Source: National Fire Incident Reporting System and NFPA's fire department experience survey

Descriptions of Natural Gas and Propane Fires and Explosions from NFPA Publications

The following incident descriptions were previously published in *NFPA Journal* or in reports by NFPA's Research, Data and Analytics Division. These incidents show what *can* happen; they should not be considered typical or statistically representative. Because NFPA actively seeks information about fatal and large loss fires, incidents in this collection are more likely to be serious.

Explosion – Firefighter Fatality

On September 27 at 6:30 a.m., a neighbor called 911 to report the smell of natural gas coming from a nearby single-family dwelling. The building, a two-story structure of ordinary construction, covered 800 square feet (74 square meters) of floor area. Arriving fire companies were greeted with a strong odor of mercaptan, a harmless, non-toxic, colorless gas with a pungent odor similar to rotten eggs. It is mixed with the odorless natural gas to warn of or trace leaks. They traced the leak to the basement. Twenty minutes after arrival, firefighters shut the gas off.

The second level of the dwelling was being used to grow illegal marijuana and was well-sealed, providing little ventilation. A horrific explosion originated in the rear second-level bedroom approximately one hour after the initial alarm. The explosion reduced the house to rubble, sending portions of the roof through the air. One such section struck a battalion fire chief who was directing operations from the middle of the street. He was taken directly to a hospital where he died from his traumatic injuries. Six other firefighters sustained non-fatal injuries.

Rita F. Fahy, Paul R. LeBlanc and Joseph L. Molis, *Firefighter Fatalities in the United States-2016*, Quincy, MA: NFPA, June 2017.

Natural gas explosion kills seven, Maryland-

At 11:55 p.m. on an August night, the fire department was notified of an explosion at an occupied three-story, garden-style, 13-unit apartment building of unprotected, ordinary construction that covered approximately 4,000 square feet (372 square meters). Although the building had smoke alarms and manual pull stations, the system was destroyed in the explosion and did not operate.

A natural gas leak in the basement allowed the basement to fill with gas and an explosion occurred. The ignition source of the explosion is still undetermined and the investigation is ongoing.

A second building of similar size and construction (but with 14 units) was also destroyed in the explosion. In addition, 26 civilians were treated for various injuries due to the explosion and fire and three firefighters were injured fighting the fire. The victims included five adults and two children, including one under age six. There was no information on the location of the victims, including which building they were in.

Adapted from Stephen G. Badger's *Catastrophic Multiple Death Fires in 2016*, Quincy, MA: NFPA 2017, p. 5.

Propane leak results in house explosion that kills one, Nebraska

Firefighters responding to a report of a structure fire with possible entrapment were notified while en route of a reported explosion, leading to a call for a second alarm. As crews reached the scene, they found that a single-family home had been leveled to the ground, with pockets of fire showing throughout the debris.

Incident command issued requests for a third alarm and for an investigator from the state fire marshal's office within minutes of arrival. Crews from engine and tanker trucks were assigned water supply and suppression responsibilities, and a responding ambulance was diverted to a nearby intersection, where an occupant who had managed to escape before the explosion was located.

After the main bodies of fire had been extinguished, crews began to search for a resident of the house who was not accounted for. Incident command requested assistance from a mutual aid company in searching for the missing resident. Crews extinguished hot spots as they continued their search efforts. Approximately one and a quarter hours after arrival, crews located the body of a female resident at the east end of the home. The victim was transported from the scene by a local funeral home after approval by the county coroner, who had been summoned by incident command.

Inspectors determined that the explosion was caused when a pilot light ignited propane gas, which was believed to have built up underneath the home, according to news accounts. The fire chief indicated in news reports that the explosion was powerful enough to lift the house off its foundation and blow the walls out, resulting in the collapse of the roof.

The resident who managed to escape the house was reported to have been treated at the hospital for non-life threatening injuries. The fatally injured resident died of blunt trauma injuries.

The single-family home was one story in height and had a ground floor area of 1,440 square feet (134 square meters). It was constructed with a wood frame, wood and stucco walls, and a metal roof.

The house and its contents were a total loss, estimated at \$175,000.

Richard Campbell, "Firewatch," *NFPA Journal*, November/December 2016.

Mother, daughter perish in house explosion and fire, Pennsylvania

A mother and her adult daughter died from injuries sustained when a hot water heater in their basement exploded as they tried to light it, igniting a fire that spread to the walls of the residence and into the attic.

Two passersby called 911 at 10:21 p.m. after hearing the explosion and finding the two-and-a-half-story house on fire, with the two burn victims and a third resident outside the residence. The passersby learned from the third resident that children were still inside the house.

As crews arrived, they reported that a fire on one side of the house was being fed by propane tanks located outside of the structure, with fire also showing from the second floor and a second-floor balcony. Incident command requested basic and advanced life support to the scene for the burn victims and indicated the need for air medical transport.

Crews established water lines to begin an initial attack to knock down the fire near the propane tanks. Firefighters then proceeded to a side entrance to begin interior fire attack and primary search. Incident reports indicate that incident command subsequently advised that all occupants were outside the house. Firefighters assisted with care of the burn victims as interior crews completed extinguishment of the fire.

The burn victims were taken by ambulance to the location where air medical units had landed, then flown to a burn unit. Three other occupants, two children and an adult, were not injured and sought temporary shelter at a neighboring house. The fire was determined to be under control by 10:45 p.m. and firefighters completed overhaul operations at approximately 12 a.m.

Investigators determined that there was a leak in the propane supply, leading to an explosion when the victims used a lighter to light the hot water heater in the basement. The relief valve on one of the propane tanks then released, starting a fire that spread up the exterior of the house.

One of the burn victims succumbed to her injuries approximately one week after the fire, and the second victim died two weeks after the incident.

The house had a ground floor of 900 square feet (274 square meters) and was constructed of wood and brick. The house, valued at \$210,000, suffered losses of \$207,000. The contents were valued at \$15,000 and experienced losses estimated at \$12,000.

Richard Campbell, "Firewatch," *NFPA Journal*, July/August 2016.

Resident dies when gas explosion sets fire to camper, Kentucky

Firefighters responding to an 8:50 a.m. report of a trailer park fire with possible entrapment arrived to find a pull-behind camper fully involved with flames. Crews initiated a rapid attack with preconnected hose lines on both sides of the camper and were able to quickly extinguish the fire.

Firefighters evacuated the sole male occupant of the trailer, who received medical assistance from an ambulance crew and was transported to the hospital with burn injuries covering 60 percent of his body, according to newspaper reports. Crews attempted to salvage as much of the trailer's contents as possible and secured the scene for safety.

Investigators determined that the fire was caused when an uncapped propane gas line allowed the trailer to fill with gas when the victim turned the tank on, resulting in an explosion when he attempted to light a cigarette. The line had been left uncapped after the victim replaced the original propane refrigerator with an electric appliance.

The victim succumbed to burn injuries in the hospital one day after the explosion.

The camper was described as a wood-frame pull-type camper. Damage was estimated at \$10,000.

Richard Campbell, "Firewatch," *NFPA Journal*, July/August 2016.

Woman dies in house fire ignited by natural gas explosion, Texas

An undetermined heat source ignited a natural gas leak in the kitchen of a single-family home, triggering a fire that killed a female resident.

A passerby alerted firefighters at 4:30 p.m. and the first units to arrive reported heavy smoke and fire coming from the front and one side of the house. One crew immediately attacked the fire from the front of the house, while another began treating the home's occupant, who had managed to evacuate the house, but received burn injuries while making her escape.

Incident command declared a defensive operation when it became apparent that the intensity of the fire precluded an interior attack. Crews laid supply lines and performed suppression tactics while two firefighters assisted in transporting the victim to the hospital. Newspaper reports indicated that the victim was flown to a burn center for treatment but died in the hospital later that day.

Based on fire intensity and travel patterns, investigators determined that the fire was concentrated in the kitchen, where they noted that the stove was out of its normal position and a gas supply line was not connected. No ignition source was identified, but the investigation determined that the natural gas explosion was due to an open gas valve.

The house, a single-story structure with an area of 1,200 square feet (366 square meters), suffered extensive damage, including partial roof collapse. The house and contents, valued at approximately \$58,000, were a total loss.

Richard Campbell, "Firewatch," *NFPA Journal*, May/June 2016

Natural gas leak in garage ignites, kills elderly man, Tennessee

An 87-year-old man died in a fire that started when he hit the HVAC unit in his garage as he tried to park his car. The impact ruptured the natural gas line to the unit, causing gas to leak into the garage and eventually ignite.

The garage was attached to a two-story, wood-frame, single-family house, which was 30 feet (9 meters) long and 40 feet (12 meters) wide. There was a smoke alarm on the second floor. There were no sprinklers.

After the man parked his car, he went inside and began to take a shower, apparently unaware that the leaking gas in the garage had ignited. Because the only smoke detector in the house was on the second floor, the victim knew nothing about the fire until he was alerted by a neighbor, who called 911. The neighbor urged the man to leave the house, but he instead went into the garage, where he was overcome by smoke.

The house, valued at \$175,000, sustained an estimated \$50,000 worth of damage. Its contents, valued at \$50,000, were destroyed.

Kenneth J. Tremblay, "Firewatch," *NFPA Journal*, November/December 2015.

Man dies in home when leaking gas ignites, West Virginia

A 45-year-old man died of second- and third-degree burns to his upper body, which he sustained when leaking LP-gas ignited in his single-family home.

The one-story, wood-frame house, which was 40 feet (12 meters) long and 50 feet (15 meters) wide, had no smoke alarms or sprinklers.

A neighbor saw the fire and called 911 around 9 p.m. by the time firefighters arrived, the blaze had spread through the entire living space and into the attic.

Investigators determined that the victim failed to shut off the gas line supplying the LP-gas heater on which he was working. When he used a lighter, the gas ignited.

The house, which was valued at \$60,000, and its contents, valued at \$10,000, were destroyed.

Kenneth J. Tremblay, 2012, "Firewatch", *NFPA Journal*, November/December, 25.

Propane explosion suspected in fatal house fire, Minnesota

A 63-year-old man died of smoke inhalation when leaking propane ignited, starting a fire that engulfed his home.

The single-family, wood-frame house, which measured 24 feet (7 meters) by 16 feet (4 meters), had a smoke alarm in the bedroom, but due to the extent of damage, fire investigators were unable to determine whether it had operated as designed. There were no sprinklers.

A passerby called 911 at 11:30 a.m. to report the fire, and responding firefighters arrived to find the house fully engulfed in flames. Initial attack teams knocked down the heavy fire and entered the house to search for the occupant, whom they found under a window in his bedroom.

Investigators believe that propane leaking from a heater in the living room filled the home until it reached an ignition source. Glass from a large window on the front of the house was found 35 feet (10 meters) away without smoke staining, suggesting an explosion before the fire began. The fire destroyed the house, valued at \$20,000, and its contents, also valued at \$20,000.

Kenneth J. Tremblay, 2012, "Firewatch," *NFPA Journal*, September/October 25-26.

Leaking LP-gas tank causes house explosion, North Dakota

Two adults were injured and their baby girl was killed when LP-gas from a leaking tank collected in the basement of their home and ignited when the water pump began operating.

The single-family, wood-frame home had a concrete block foundation and a roof covered with asphalt shingles. The presence of smoke alarms or sprinklers was not reported.

When the family arrived home in the late afternoon on the day of the explosion and smelled gas, they opened the windows and left the house for a while. When they returned, they could still smell gas, so the man told the woman to go outside with the baby. He then went to the basement to turn the water heater control to pilot and returned to the first floor. He had just turned the faucet in the bathroom on to wash his hands when an explosion demolished the house. It was later discovered that turning the water on caused a drop in the water tank pressure, creating a spark that caused the LP-gas to explode.

Neighbors heard the explosion and called 911 at 7:46 p.m., then went to help the family. They found the man in the wreckage of the house and the woman some 50 feet (15 meters) away from it. The baby was found dead more than 75 feet (23 meters) away from the house. All three were taken to the hospital.

Investigators traced the leaking LP-gas to a 500-gallon (1,893-liter) tank. The occupants had requested a delivery of LP-gas the night before the explosion because they had run out, and the gas was delivered that day. The delivery person did not detect the leak at the valve.

The investigator concluded that the delivery person had not properly tested the tank regulator and shut-off valve because the family was not at home when he delivered the gas. Nor was the tank red-tagged, or the occupants instructed to call to have the lines bled and pilot light relit. Over time, the leaking gas accumulated until the water pump provided the ignition source.

Neither loss estimates nor the victims' ages were reported.

Kenneth J. Tremblay, 2012, "Firewatch," *NFPA Journal*, May/June, 38.

Leaking natural gas ignites, Massachusetts

A 30-year-old utility employee was injured when natural gas drawn into the intake of a heating unit ignited as he changed a gas meter on the exterior of a wood-frame residential condominium building.

The exterior of the three-story, seven-unit building, which was 150 feet (46 meters) long and 30 feet (9 meters) wide, was sided with wood, and its roof was covered by asphalt shingles. A wet-pipe sprinkler system had been installed throughout, and local smoke alarms were located in each unit.

Investigators determined that the worker had begun changing the meter without shutting off the gas supply, causing the gas to leak. Once the fuel entered the heating unit intake, it ignited, and flames spread along the exterior into the soffit and the building. After fire spread inside, an unknown number of sprinklers helped confine the fire to the building, but firefighters could not extinguish the blaze until the utility company shut off the gas line feeding the structure.

Damage to the property was estimated at \$975,000.

Kenneth J. Tremblay, 2011, "Firewatch," *NFPA Journal*, January/February, 20 .

Propane explosion kills six, New York

At 12:30 p.m. on a July afternoon, an explosion at a two-story, single-family home of unprotected wood-frame construction was reported to the fire department. Heat from a hot water tank ignited propane that had leaked into the basement, causing the explosion which levelled the house. The source of the propane leak was not reported. Six people were killed, including a child under six years of age.

Adapted from Stephen G. Badger's *Catastrophic Multiple-Death Fires for 2011*, Quincy, MA: NFPA, 2012.

Five dead after natural gas explosion; Pennsylvania

At 10:50 p.m., the fire department was notified of the incident in a two-story, single-family home of unprotected ordinary construction. The explosion and fire occurred when natural gas leaked into the basement. The ignition source was undetermined. No information was reported on the source of the gas leak. There were no smoke alarms or automatic suppression equipment.

This home was one in a block of two- and three-story row houses. Arriving firefighters evacuated nearby houses and buildings and began fire suppression operations. While fighting the fire, they found a second natural gas fed fire. No information was reported as to the victims' locations. One firefighter was injured.

Adapted from Stephen G. Badger's, 2012, *Catastrophic Multiple-Death Fires for 2011*, Quincy, MA: NFPA, 2012.

Leaking propane ignites after piping damaged, New Hampshire

The occupants of a single-family home managed to escape a fire started by a low-order explosion in their basement.

The three-story, wood-frame house was 38 feet (12 meters) long and 26 feet (8 meters) wide. Hardwired smoke alarms were located on each floor, including the basement, and in each bedroom, and they operated as designed. The house had no fire suppression system, although a single sprinkler had been installed above the furnace in the basement.

*Natural Gas and Propane Fires, Explosions and Leaks
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Shortly before the explosion occurred, an employee of a lawn-care company mowing the lawn hit piping leading from a propane tank to the gas-fired water heater in the basement with a thud, causing the pipe to leak. One of the occupants of the house looked out the window and saw the employee looking at the gas regulator. The crew left within minutes, and the explosion occurred shortly afterward, as one of the occupants was taking a shower in an upstairs bathroom.

Firefighters called to the scene at 10:15 a.m. arrived to find that the occupants had safely evacuated the house and had shut off the propane line. They also found the sprinkler operating above the furnace. Water from the sprinkler and from plastic pipes that had burned through extinguished the fire.

Investigators discovered a break in the gas line near the elbow where it entered the basement and determined that the demand for hot water caused the water heater to start and ignite the leaking propane.

The house, which was valued at \$171,400, and its contents, which were valued at \$100,000, sustained damage estimated at \$15,000 and \$10,000, respectively. There were no injuries.

Kenneth J. Tremblay, 2011, "Firewatch", *NFPA Journal*, July/August, 17-18.

Gas explosion injures child, kills grandfather, Pennsylvania

A 4-year-old girl was injured and her 74-year-old grandfather was killed when natural gas ignited in their single-family home and blew the entire structure to pieces.

The two-story, split-level, wood-frame house was 50 feet (15 meters) long by 30 feet (9 meters) wide. Its exterior walls were covered with a brick façade, and the roof was covered with asphalt shingles. Investigators could not determine whether smoke alarms were present, but there were no sprinklers.

The grandfather and child had returned home at 1:40 p.m. and smelled a strange odor. Leaving his granddaughter sitting on a sofa in front of a large window in the living room, the man went to the basement to investigate when the explosion occurred, blowing the house apart and starting a huge fireball that engulfed the remains of the dwelling. The explosion also severely damaged five other homes or related structures nearby.

A neighbor found the girl, who had been blown through the window, in the debris some 30 feet (9 meters) from the house. Both her legs were fractured but she was conscious and breathing. Her grandfather was found outside the house near his parked car. He was still alive, but he had suffered third-degree burns over 30 percent of his body, as well as major trauma to his trunk. Both victims were taken to hospitals, where the grandfather died a few hours later.

Kenneth J. Tremblay, 2009, Firewatch, *NFPA Journal*, May/June, 33-34.

Propane Explosion Ignites Home and Kills Two, Nebraska

A 68-year-old woman and a 66-year-old man died in their single-family home when leaking propane filled the house and ignited with explosive force when one of them turned on a propane-fired heater.

The single-story, wood-frame dwelling, which was 30 feet (9 meters) wide and 50 feet (15 meters) long, had no smoke or fire suppression equipment.

A passerby heard the explosion and saw the fire and reported the incident at 5:30 a.m. Investigators determined that a propane distributor had recently filled the home's tank and lit the pilot for the upcoming heating season. When the occupants awoke and turned on the furnace to take the chill out of the house, the home exploded and burned. Investigators found a small leak in the copper tube.

The house, valued at \$75,000, and its contents, valued at \$50,000, were destroyed.

Kenneth J. Tremblay, 2008, "Firewatch", *NFPA Journal*, November/December, 23.

Natural gas leak causes explosion and fire, Massachusetts

Six people were injured in a fire in a two-family, wood-frame home that started when a gas water heater ignited an uncontrolled release of natural gas leaking into the house.

Six college students occupied the two-and-a-half-story, unsprinklered house. Smoke alarms were reportedly located on all floors, but investigators could not be sure because of the extensive damage.

A police officer was nearby helping a construction crew that was digging up the road when the house exploded and collapsed. Approximately 10 seconds later, a second explosion occurred, and fire was seen in the debris. The officer called the fire department at 11:08 a.m., and firefighters arrived within minutes to find 75 percent of the house involved in fire. A house next door was also damaged and threatened by fire when crews arrived. Firefighters used large master streams to control the fire, then multiple hand lines to extinguish it.

Investigators determined that gas entered the home under pressure and that it ignited with explosive force when it reached the basement water heater.

The house, valued at \$220,000, and its contents, valued at \$110,000, were destroyed. The house next door was condemned, and several other homes and some vehicles were also damaged. The six victims, who were taken to area hospitals with serious to minor injuries, ranged in age from 21 to 47

Kenneth J. Tremblay, 2008, Firewatch, *NFPA Journal*, September/October, 23.

Natural Gas Explosion Destroys House and Damages Two Others, Ohio

Leaking natural gas ignited by an unknown source exploded and completely destroyed a dwelling. The bodies of a 17-year old female and a 43-year old male were found in the structure.

The two-story, single family home was constructed of wood framing with a wood truss roof covered by asphalt shingles. Measuring 36-feet in length and 28-feet in width the home did not have any smoke alarms or sprinklers.

A device, commonly called a "snake," was being used to clear the main sewer line of the home. The snake apparently exited the main sewer line at some point underground and cut into a natural gas line servicing the house. Leaking gas filled the main sewer line and basement of the home until an ignition source was found. The explosion heavily damaged the home as fire consumed the dwelling and spread to adjacent properties on either side. Estimates of loss were not reported.

Kenneth J. Tremblay, 2007, Firewatch, *NFPA Journal*, July/August 27.

Natural gas leak ignites, killing two, Texas

Two people were killed and two others severely injured when natural gas leaking from a faulty piping system into an apartment ignited.

Investigators found that the piping in the two-story apartment building had corroded, allowing natural gas to be drawn into pipe chases from holes in the pipes and, from there, into the living spaces.

The 12-unit building had brick and cinderblock walls, concrete-slab floors, and a concrete-slab roof. There were six units on each floor, and interior concrete-block walls separated them into quadrants, or sections, with two units up and two down.

A single-station smoke alarm in the living room of one apartment operated during the fire, but investigators could find no trace in the debris of a second smoke alarm that had been installed in the bedroom.

The four occupants of a second-floor apartment were in their living room at 9:20 p.m. when the explosion and fire occurred. Investigators determined that it started in one of the unit's bedrooms and spread from there to the living room and kitchen. The low-order explosion shattered windows throughout the unit and distorted and dislodged the window frames.

Firefighters extinguished the fire as the four victims were treated for burns and smoke inhalation and taken to the hospital, where two of them, a woman and a 4-year-old, died of their injuries.

Investigators found a hole nearly 1 foot (30 centimeters) long in an underground pipe near the entrance to the apartment building's utility chase. They also found leaks in fittings near a gas-fired water heater and stoves in two of the units. However, the investigators were not able to determine the exact ignition source.

Neither the value of the building and its contents nor the estimated property damage was reported.

Kenneth J. Tremblay, 2005, "Firewatch," *NFPA Journal*, September/October, 32.

Gas explosion kills two, West Virginia

A 29-year-old woman and a 34-year-old man died when natural gas exploded in their apartment. A passerby called 911 at 7:18 p.m. to report the explosion at the two-story, wood-frame building.

Investigators determined that natural gas exploded in a bedroom of the second-floor apartment when it was ignited by an unknown source. There were smoke alarms in the bedrooms; investigators could not determine whether they operated.

The duplex, which was valued at \$70,000, and its contents, which were valued at \$15,000, sustained \$65,000 in damage.

Kenneth J. Tremblay, 2005 "Firewatch," *NFPA Journal*, July/August, 16+18.

Propane explosion kills one, Iowa

An 89-year-old man died after leaking propane ignited, exploded, and destroyed his single-family house. Firefighters found the man's body outside what was his bedroom.

The single-story, wood-frame house, which was 32 feet (9.8 meters) long and 39 feet (12 Meters) wide, had no basement. There were no sprinklers, and investigators couldn't determine whether the home had any smoke alarms.

Neighbors awoke to a loud explosion and found broken glass on their bed. The victim's home was dark, but some small fires were visible toward the rear of the home. Shortly afterwards, flames shot high and consumed the house.

Arriving firefighters, responding to an 11:40 p.m. 911 call, used hose lines to protect the house next door and began searching for the victim.

A propane delivery employee told investigators he had tested the line leading to the house from a 500-gallon (1,893-liter) cylinder for leaks the afternoon before the explosion. He filled the tank with approximately 250 gallons (946 liters) of propane gas and shut the valve, leaving a notice of the test, delivery, and status of the valve, along with a warning to check the system before turning on the cylinder.

The investigators learned that a propane-fueled water heater had been replaced with an electric one. Because of the heat damage, it was impossible to tell the condition of the branch line before the fire.

Investigators determined that the explosion resulted from a propane leak in the home. The ignition source couldn't be determined.

The house, valued at \$10,000, and its contents, valued at \$10,000, were destroyed. The victim died of exposure to fire.

Kenneth J. Tremblay, 2004, "Firewatch," *NFPA Journal*, September/October, 14.

Fire kills elderly woman, Texas

An 86-year-old woman died when her gas-fired water heater ignited natural gas leaking from a connection in the kitchen, which was undergoing renovations.

The one-story, wood-framed single-family house was 46 feet (14 meters) long and 31 feet (9 meters) wide. Smoke alarms were located in the hallway outside the bedroom door and in the living room. There were no sprinklers.

The kitchen was being remodeled and the gas stove had been disconnected and moved 2 feet (0.6 meters) from the wall. The woman's walker caught the gas connection causing the valve to open, and release natural gas into the house. The water heater, located in the kitchen, was operating and ignited the escaping gas, causing an explosion that engulfed the house.

Damage to the house, valued at \$47,000, and its contents, valued at \$15,000 was estimated at \$55,000.

Incidents of this type have been address in [NFPA 54](#), *National Fuel Gas Code*, for many years. The Code states that each outlet "including a valve, shall be closed gastight with a threaded plug or cap

immediately after installation and shall be left closed until the gas utilization equipment is connected thereto plug or cap immediately it shall be closed gastight.

Kenneth J. Tremblay, 2004, "Firewatch", *NFPA Journal*, July/August 16-17.

Explosion, fire kills three children, Ohio

Natural gas escaping from a malfunctioning water heater ignited explosively, resulting in a fire that spread quickly through a single-family home, then to the house next door. The three adults in the house of origin were injured, and the three children, ages 1, 2 and 6, were killed. The two-story, wood-framed house had no smoke alarms or sprinklers.

A neighbor called 911 to report the fire at 11:56 p.m., and firefighters arriving two minutes later found that the blaze had already spread to both floors of the building and was moving to the house next door. The three adults had managed to escape and were taken to the hospital for treatment of burns, while firefighters tried unsuccessfully to rescue the children, who all died of exposure to products of combustion.

Witnesses all reported hearing an explosion before seeing flames and investigators determined that it occurred in a rear porch on the first floor, near a gas-fired water heater surrounded by a clutter of common combustibles. They couldn't determine how the gas had leaked from the unit, but they suspect the regulator failed or a falling object damaged the heater.

The building, valued at \$45,000, suffered damages estimated at \$25,000. The injured all suffered from burns and smoke inhalation.

Kenneth J. Tremblay, 2003, "Firewatch", *NFPA Journal*, May/June, 18.

Synopses of NTSB Reports on Natural Gas and Propane Pipeline Incidents involving Homes

[Preliminary Report: Natural Gas-Fueled Explosion of Residence, Dallas, Texas, February 23, 2018](#)

A natural gas explosion killed a 12-year old, injured four other family members and caused major damage to a single-family home. No fire or smoke damage was seen. Survivors reported hearing unidentifiable “popping” noises the night before, but did not smell gas before the explosion. In the two days before the explosion, gas company crews were in the neighborhood investigating two gas-related fires.

On February 21, the occupant of a home 415 feet from the fatal explosion woke to a “popping” sound from the heating, ventilation and air conditioning (HVAC) unit. In the attic, he saw that the HVAC cover was on the floor rather than on the unit. An explosion occurred when he put the cover on the HVAC unit. The explosion pushed him back and he was burned.

On February 22, the resident of a home 310 feet from the fatal explosion was boiling water when the stove flame was “red and out of control.” The fire spread from the range to the attic, destroying the home.

The gas company found multiple leaks and began repairs on February 22. Leaks had been detected on January 1, and some work had been done before these incidents. More leaks were identified, and gas was shut off for more than three weeks. The investigation is ongoing and the cause has not yet been determined.

[Natural Gas-Fueled Building Explosion and Resulting Fire NYC, NY - March 12, 2014](#)

A natural gas-fueled explosion and fire destroyed two five-story mixed-use properties, damaging other properties, killing eight people, injuring more than 50 and displacing more than 100 properties. Several people acknowledged smelling gas the night before the incident but none called the gas company. The NTSB identified two factors as the probable cause. A defective fusion joint at the three-year-old service tee failed, letting gas leak from the main into the building. A sewer line breach present since at least 2006 reduced the gas main support. Without that support, the gas line sagged and put more stress on the defective joint.

[Pipeline Accident Brief: Birmingham, Alabama Public Housing Gas Explosion, December 17, 2013](#)

A natural gas explosion destroyed one unit of a duplex and damaged another. Two people sleeping downstairs were crushed when the second story collapsed; one died. Three sleeping upstairs were blown out of the unit; two were injured.

The fire department put out the structure fire but gas from a broken pipe line riser next to building continued to burn for a few hours until the gas could be shut off.

Duplex occupants and neighbors reported smelling gas for up to two weeks before the incident. The gas company had received several reports of gas odors from the area in the past few years, but not from occupants of the duplex. Duplex occupants reported smelling gas outside the home, and noticed a faint odor inside the home

The NTSB identified damage caused by tree growth that cracked a 62-year-old corroded cast-iron gas main as the probable cause of the leak. An appliance pilot light ignited gas that had leaked into the apartment. Most of the odorant had been absorbed by the soil so that occupants were unaware of the gas build-up.”

[Columbia Gas Transmission Corporation Pipeline Rupture, West Virginia, December 11, 2012](#)

Three houses were destroyed and others damaged after a buried 20-inch natural gas pipeline ruptured and the spewing gas ignited. No fatalities or serious injuries occurred. The NTSB identified several probable causal factors leading to the pipeline rupture, including external corrosion of the pipe wall and a lack of inspection or testing since 1988. Rocky backfill was also a contributing factor.

[Pacific Gas and Electric Company Natural Gas Transmission Pipeline Rupture and Fire San Bruno, CA, September 9, 2010](#)

Eight people died, many more were injured, 38 homes were destroyed and 70 homes damaged after the rupture of 30-inch natural gas pipeline and ensuing fire. The NTSB learned that quality assurance and control were inadequate when the pipeline was installed in 1956. This “allowed installation of a substandard and poorly welded pipe section with a visible seam weld flaw that, over time grew to a critical size, causing the pipeline to rupture during a pressure increase stemming from poorly planned electrical work.” The pipeline integrity management program was inadequate. Policies that exempted existing pipelines from required pressure tests and flaws in the pipeline integrity management program played a role. Lack of automatic shutoff and remote control line valves were also factors.

[Explosion, Release, and Ignition of Natural Gas Rancho Cordova, CA, December 24, 2008](#)

One person died, and five were hospitalized after a natural gas leak caused an explosion and fire. One house was destroyed, two severely damaged and others sustained minor damage. A resident reported a gas odor outside her home in the morning. The NTSB found that a part of the polyethylene pipe did not meet specifications and did not have a thick enough wall, so that gas could leak from a mechanical coupling. The utility, per its policy, sent a technician, rather than a leak inspector trained in outdoor leaks, after the initial complaint, resulting in a delay of almost three hours before someone with the right training and equipment arrived.

[Natural Gas Distribution Line Break and Subsequent Explosion and Fire Plum Borough, PA, March 5, 2008](#)

A man was killed and a 4-year old girl seriously injured when a gas explosion and ensuing fire destroyed four houses and damaged 11 more. Neighbors who were interviewed had not smelled gas before the explosion. The NTSB identified excavation damage from a sewer line replacement five years earlier as the probable cause of damage to the pipe’s protective coating that led to pipeline failure. Because no one smelled gas, the NTSB believes that the pipeline failed rapidly. Gas could have entered the home through the porous backfill for the sewer line.

[Rupture of Hazardous Liquid Pipeline with Release and Ignition of Propane, Carmichael, MS, November 1, 2007](#)

A 12-inch pipeline for liquid propane ruptured, causing a gas cloud that became a fireball. The ensuing fire caused two deaths and seven minor injuries, as well as destroying four homes and damaging several others. The NTSB determined that a weld failed, causing the pipe to fracture.