New House Fire Hazard: Exploding Attic Stairs

08/28/2013

By Chris Kear and Jerry Knapp

This article aims to make firefighters aware of a new hazard found in residential fires and suggests possible tactical changes to minimize this new threat to firefighter safety.

Modern house fires seem to be getting more and more dangerous and surprising every day. New construction materials and methods, modular construction, and increasingly flammable building materials will require changes to our traditional search, rescue, and ventilation strategies at residential fires. The new threat to firefighters' lives and safety is the widespread residential use of gas springs or, as they are known to us, struts. Struts make home furnishing easy to open or close safely and are used in kitchen cabinets, toy boxes, furniture, office and reclining chairs, and household appliances and fixtures.

This article will examine the effect of a residential fire on gas springs used in a specific application: pull-down attic stair assemblies. By using a case history at a recent residential attic fire, we will review the causes, effects, and tactical changes from a gas spring rocketing past the nozzle team, narrowly missing striking two firefighters.

GAS SPRING ANATOMY AND FUNCTION

Gas springs, as the industry calls them, consist of a pressure tube (heavy gauge steel cylinder), a piston rod and a piston (hardened steel chromium-plated precision ground and highly polished), and a sealing system. The unit is sealed to the outside atmosphere and contains 250 to 2,500 pounds-per-square-inch (psi) of compressed nitrogen. The energy for the spring effect comes from the compression of the gas sealed in the unit by the piston. When the rod and piston are pushed against the gas inside the sealed cylinder, a spring-like force is generated against the direction of the push.

Gas springs are replacing coil springs as counter balances on pull-down attic stairs. Industry Web sites (attic stair and gas spring, i.e., strut manufacturers) state that these gas springs provide a better, easier, smoother operation with less effort and are not as noisy as coil springs. Obviously, you will find them in new residential construction and in replacement pull-down attic stairs, as it was with the main focus of the case history that follows. They are cheaper to purchase and install than standard springs.

These units are filled with nitrogen and a small amount of lubricating oil. If they were filled with air when the piston rapidly compresses the air, there will be a dramatic rise in temperature and, as such, could ignite the oil; this is much like how a diesel engine operates. Nitrogen is inert and will not combust.

Oil is required to be in the cylinder to keep the seals lubricated and improve the seal life and capacity, hence the functionality of the gas spring assembly. The oil also has a dampening effect on the last few fractions of an inch in the stroke length.

The seals can be made from several materials: nitrile, teflon, rubber, or viton. The seals will wear out over time, ending the useful life of the gas spring. Also, the seals play a key role in the strut/gas spring not being able to withstand the high temperatures of fires.

Gas springs are anchored on each end by a wide variety of end fittings made of everything from stainless steel to nylon to plastic composites reinforced with fiberglass. The nylon and plastic end fittings also play a key role in their dangerous reaction to fire conditions.

USE OF GAS SPRINGS

As previously mentioned, these devices are being used in many areas of residential occupancies. We are familiar with their use on our car hatchbacks, rear SUV windows and, of course on the infamous exploding car bumpers. Their proliferation in residential occupancies is relatively new, especially in attic stair assemblies. They are not designed to be used in any areas where high temperatures can be reached. Gas springs are closed/sealed cylinders with high-pressure gas inside **with no relief valve**. Manufacturers do not recommend their use in areas that will exceed 150°F, although "high temperature" units

are available to withstand 350°F. We know from National Institute of Safety and Technology and Underwriters Laboratories data that a simple room-and-contents fire with adequate ventilation will reach 2,000°F+. Typical temperature ranges for application of gas springs is from -4°F to -150°F because of the nature of the sealed unit, seals, and high pressures of compressed gas.

CASE HISTORY

Former Hillcrest (NY) Fire Department Chief Chris Kear provides the details of this dangerous close call case history involving gas springs, which follow:

"We responded mutual aid at the request of the Spring Valley (NY) Fire Department to a row house fire at 53 Gladys Drive. Chief Ken Sohlmann was the IC, and his size-up revealed a fully involved (both first and second floors) middle unit of an attached row house approximately 25 × 45. The Spring Valley Fire Department did an excellent job in knocking this fire down. The heavy body of fire caused it to extend to the attached unit."

Fire had vented out the rear window of the fire building and autoexposed the soffit of the B exposure and had gotten into the attic. We were assigned to enter this unit and extinguish the attic fire. Lieutenant Corey Martin of the Hillcrest Fire Department entered with me with an 1¾-inch hoseline. I took a quick peek inside, and both the first and second floors had a very light smoke condition from the original fire, but I could see what appeared to be a heavy fire condition in the attic. The pull-down stairs had sagged down about 18 inches, giving me a clear view of a good body of fire above the ceiling. It appeared to be a normal attic fire."

Kear continued, "While we masked up at the bottom of the main stairs (to the second floor), what sounded like a shot rang out from somewhere on the second floor. I did not think too much about it—maybe an aerosol can exploding or something similar. The explosion did not change the fire condition, so it seemed insignificant."

I ascended the stairs and just made the top step when I heard a hissing sound. It was not really loud and did not sound threatening, like a leaking pressurized cylinder or anything very dangerous worth considering. The noise was only a few seconds; it stopped and, again, it did not change the fire condition or our situation. Smoke was starting to bank down on the second floor from the attic, but visibility was good on the stairs and the second floor.

Lieutenant Martin, with the nozzle, was behind me on the stairs, and he had a helmet camera on and caught the action. In the video you can hear the first explosion at 128 seconds into the video (while we are donning our masks), and 18 seconds later, at 143 seconds, you can see the missile go flying past me from my right to left, but just behind me and in front of Lieutenant Martin's camera."

In this short video, you can hear the first strut exploding, then at the very the second strut flies from the top right to the lower left of the frame:

This screen shot shows the gas cylinder lodged in the wall on the left-hand side:

WHAT HAPPENED?

Firefighters behind me saw (and which was captured on video) what we later determined to be a gas spring from the pull-down stairs apparently become over-pressurized and launch from the pull-down attic stairs, shoot past and behind me, and imbed into the wall on the main staircase. A concrete fire wall behind the sheetrock stopped the cylinder and left it imbedded in the wall.

The first explosion was the failure of a gas spring cylinder that apparently remained on the pull-down stairs. We found this strut still attached by one end during overhaul. The picture below shows how much energy was released when it exploded.

(1) Note the threaded ends of the strut are still intact and not damaged. The bend in the strut leads us to believe it is possible that it expanded while still fixed to the unit and was under excessive pressure with the cylinder wall seam failing as the weakest point.

(Photos by Jerry Knapp.)

(2) Complete view of the first gas spring that exploded. The rod is still in place and the threads intact on both ends. Did this force the stairs downward, as reported by first in firefighters? If springs held up the pull-down stairs, heat may have caused them to lengthen and sag. This one remained in place (attached by one end) and was removed by the fire inspector from the damaged pull down stairs.

It is important to consider the extremely high pressures involved in this device and the additional increases in pressures caused by the heating of the sealed cylinder. Department of Transportation's 49 CFR regulations require the cylinder to withstand four times the working gas pressure it holds inside of it. At a minimum, that is 1,000 psi (250 x 4) and a maximum of 10,000 psi (2,500 x 4). Sudden release of these pressures can and, in this case, did provide a significant amount of thrust to propel the cylinder toward the firefighters.

The second gas spring (photo 3) failed in apparently a different way: in a projectile, rocket-like manner. As previously described, it went whizzing behind me and in front of the nozzle man and helmet camera. It was relatively silent; just a short hissing sound. In fact, I did not even hear it over the sounds of the radio, self-contained breathing apparatus (SCBA), and so on. It seems it would have gone completely through the wall had it not been for the concrete block fire wall. Clearly, this projectile could have caused serious injury or death to a firefighter, especially if he was struck in the head or vital area. It flew about 12 feet, launching from the attic opening and coming down and across the main stairs, imbedding into the wall.

(3) The second cylinder rocketed and imbedded in the wall. The cylinder, the piston rod, and the threaded connections at each end are all intact. The rod moves freely, without resistance, for the length of the throw of the cylinder, but it feels as if the seal at the end of the rod inside the cylinder was damaged and no longer sealed.

It is not clear why the struts failed in two different ways—one exploding and one rocketing. Both have screw-threaded ends and, apparently, were firmly fixed to the pull-down stairs. It was clear that there were two threats to firefighters: First, the missile hazard of the entire gas spring impacting and possibly impaling/spearing a firefighter. Second is the fragmentation hazard caused by the exploding strut while remaining in place.

The best case failure scenario shows that the gas spring remains in place (fixed at both ends) and the seals fail, harmlessly releasing the pressurized gas inside. It seems that the worst case was a melting of the attachment points and a flying cylinder/spear propelled by a 10,000-psi rocket motor. It is unclear the extent of the injuries a firefighter may suffer from getting hit with a failed gas spring during a fire attack. Obviously, a direct hit to the head, neck, or other vital area would result in significant injury or death. It seems likely that it would also penetrate an SCBA face piece with unpleasant results. It is also unknown at this point what degree, if any, protection turnout gear will provide.

Although we are speculating, it appears that the first gas spring was fixed in place and pushed open the pull-down stairs when the stroke extended and then became jammed against something. With no other failure scenario—the piston was against the end of the cylinder, providing a reinforced seal—the cylinder casing failed, most likely along a seam. The second (flying spring) apparently had the end fittings melted off by the fire's heat; this heat also increased the gas pressure, failing the seals at the end of the unit, releasing the gas that provided the thrust. These scenarios would account for the metal threads on each end of both springs were not damaged. Therefore, we believe they were released when the end units melted off.

ALTERNATE TACTICS

Through literature research and fire service contacts, we could find nothing based on fire experience, case histories, scientific fact, or testing which seems prudent and practical for this scenario. However, there are two things we can do to minimize the danger of exploding struts in attic stairs.

First, if the gas springs are exposed to heavy fire and the attic stairs have sagged, apply water from the bottom of the main stair case as you would to any pressure cylinder that has flame impingement, cooling it from a distance. This puts you at as great a distance as possible should they explode. Time, distance, and shielding are your allies.

Second, if you have to open the pull-down stairs to gain access to the attic use a hook and position yourself behind the stairs or on the hinged side. The pull-down stair ceiling panel will provide some shielding for you. However, bear in mind that the struts are on the sides of the pull-down unit, so protection is minimal. A short utility rope can increase firefighters' safety by allowing the firefighter that is pulling down the stairs to be further away or even in an adjacent room behind protective cover. Attach your utility rope to the ring, chain, or rope that occupants use to pull the stairs down.

Initially, this incident was great kitchen table discussion and banter. On further investigation, it proves to be another threat to firefighter safety and survival.

If you have any experiences similar to the one described above or comments, please contact Chief Chris Kear at cgk249@msn.com or at the following adress:

Rockland County (NY) Fire Training Center

35 Firemen's Memorial Drive

Pomona, New York 10970

(845) 364-8800.

CHRIS KEAR *is a past chief of the Hillcrest (NY) Fire Department and a career firefighter in the Town of Greenwich, Connecticut. Kear is also the fire inspector for the Village of New Hempstead, New York.*

JERRY KNAPP *is the assistant chief for the Rockland County (NY) Hazmat Team and a training officer at the Rockland County Fire Training Center in Pomona, New York. He is a 35-year veteran firefighter/EMT with the West Haverstraw (NY) Fire Department, has a degree in fire protection, and was a nationally registered paramedic. Knapp is the former plans officer for the Directorate of Emergency Services at the United States Military Academy in West Point, New York.*

MORE JERRY KNAPP

- **Realistic Firefighter Training: "Do It" Drills**
- **Suburban Firefighting: Plan B, Force Multiplier**
- **Suburban Firefighting: Target Hazards: Telephone Company Walk-Through**
- **More Suburban Firefighting**

Article courtesy of Fire Engineering Magazine – 08/28/2013

http://www.fireengineering.com/articles/2013/08/new-house-fire-hazard-exploding-attic-stairs.html?cmpid=EnlFireEngWeeklyAugust292013