ELECTRICALLY INDUCED FUEL GAS FIRES

Gas fires vary in their ease of investigation, depending primarily on the amount of damage sustained at a loss site. If an explosion has occurred, finding the source of a gas leak can be a very trying experience. If the fire was caught early in its infancy, the source of the gas can often be determined with little difficulty.

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An electrically induced gas fire is a type of gas fire that occurs when electrical current passes through a gas appliance (natural or LP), with the current damaging the gas delivery system and brining about a fuel leak and resultant fire. This type of fire will always have associated with it some electrical fault that started the unfortunate sequence of events. The damages to gas pipes (and possibly gas appliances) associated with these types of fires are unique, and can be used as clues in investigating the fires. It should also be noted that the physical damages to appliances and piping can lead the investigator down the wrong road if the physical evidence is not understood. Described below are several fires that occurred when electrical activity brought about leaks in gas appliances and delivery systems.

Case 1.

This fire was diagnosed as a possible arson event by the original investigator . There were two separate points of origin, one being at the gas control valve on a water heater and the second being at the point where the flexible gas line mated to a steel nipple at a gas fired furnace. The investigator noted what appeared to be 'hacksaw' marks on the gas flex line to the furnace. Thus, the hacksaw marks and the multiple points of origin indicated a fire that was possibly brought on by criminal activity.

Photo 1. Microscopic view of what was originally believed to be a hacksaw mark.

Photo 2. End of flexible gas line with most of the flare having melted due to electrical activity.

A photomicrograph of the hacksaw mark is shown in Photo 1, while the flared end of the gas line to the water heater is shown in Photo 2. The hacksaw mark is actually a notch left in the flex line brought about when the line shorted against the metal case of the furnace. The flare fitting on the gas line has been almost completely disintegrated by electrical activity.

Investigation of the furnace shows it had a two conductor (i.e., ungrounded) male plug present for power; thus, the furnace used the gas piping system for its ground. Following the fire. the furnace was replaced because of the fire damage. Testing of the outside air conditioning condenser/compressor system showed that the compressor was faulted internally. In this fire, the sequence of events was as follows:

1. Failure of compressor, causing shorting of the windings to the frame of the compressor

2. The electrical current was carried via the copper refrigerant lines to the furnace

3. The current to the furnace traveled to the gas line on the furnace, creating a leak at the point where the gas line mates with a steel nipple

4. Some of the current now on the gas line system was also carried to the water heater, where the gas line at the water heater now failed and allowed gas to leak.

Case 2

This fire occurred in a heater closet in a residence. The fire was thought to have possible occurred because of some type tampering with the gas lines. The fire originated at a leak in the gas line at the point where the flexible gas line attached to the furnace. Photo 3 shows the end of the flared gas line, it shows almost complete erosion of the flare.

Photo 3. End of gas line with flare being destroyed by electrical activity.

Examination of the outside air conditioning condenser unit shows that it was protected by two 30 ampere fuses, one of which was blown. This fuse was replaced during the investigation, and power was applied to the condenser. The new fuse blew immediately, with peak inrush current being measured at 380 amperes. Megger testing of the compressor showed a failure of the compressor inside, and one of the feed through for the windings on the hermetic compressor was found to be heavily damaged by excess electrical currents.

The sequence of events in this fire was virtually the same as in Case 1.

Case 3

This fire was once again a fire with two separate areas of origin. A utility crew had been trimming trees in a backyard, and limbs fell onto the triplex service drop feeding the house. The house was served with conventional 120/240 VAC. The service drop had pulled away from the meter base on the outside of the house because of the weight of the tree limbs. At the time the limbs fell, two separate fires broke out: one at the meter base, and one in the garage at the gas fueled water heater.

Examination of the meter base showed extensive melting of metal where one of the hot leads from the service drop had contacted it. This shorting and arcing was the cause of the fire at this location. The damage caused by the limbs had pulled the neutral off of the meter base, and the voltage now applied to the meter base by one of the hot leads energized the ground system in the residence. This ground system included the water heater and its gas lien. The flex gas line and its flared end are shown in Photo 3; as before, the electrical erosion of the flared end is extensive. Examination of the house showed that it did not have a cold water ground or ground rod; thus, the gas line served as the grounding system.

Photo 4. Side view of gal line in Photo 3, with the polymer coating still relatively intact because of protection provided by the brass nut.

Case 4

This fire occurred as an air conditioning repairman was working on an outdoor compressor unit. Power was applied to the compressor via a disconnect switch, and considerable popping was then heard in the attic. Shortly thereafter, a fire was observed in the attic, occurring at the gas fired furnace. Testing of the compressor after the fire showed that it had shorted out internally. Testing of the circuit breaker protecting the compressor showed that it had a faulty trip mechanism, and was very tardy in responding to an overload. Examination of the gas lines and regulator were carried out. The flared fitting on the gas line had sever arcing present. The gas control valve could not be examined, its die cast aluminum body having melted in the fire.

Discussion

These four fires demonstrate how electrical energy in a fault situation can travel along a gas line, creating a leak in the gas line and a resultant fire. The fires that occurred in these instances were all brought about because of electrical faults, and yet, none of these fires would normally be considered to be 'electrical' in nature. In the first fire, a cursory examination correctly showed multiple points of origin. With both the first and second fires, the damage to the furnaces/air handler units meant that the air conditioner compressors would not have been run until after the furnace damage was repaired; i.e., the actual faults in the compressors would not have been detected until after the investigation was complete and the structure repaired. This is of course a dangerous situation, because the occupants were not aware of the internal faulting at the compressor. Had the compressors not been examined after the fire, there is a real possibility that the fires would have once again occurred when the furnaces were replaced and power again applied.

The typical natural gas line is usually not thought of as a good ground. The metal components that make up a gas train are made from materials that are chosen for their ability to safely carry natural gas and the accompanying odorant. These metallic components are not known for their ability to carry electrical current. To further compound matters, it is not uncommon to find pipe joints treated with Teflon tape or plumber' putty; neither material is considered an electrical conductor.

The National Fuel Gas Code calls for the above ground gas piping system to be electrically continuous and also bonded to a grounding electrode (NFPA 54 3.14). The same section *prohibits* the use of the gas piping system as the grounding conductor or electrode. Section 5.6 of the same code requires the usual *NEC* adherence. The author's experiences indicate that the gas appliance that is not properly grounded is more susceptible to gas line arcing than is the properly grounded appliance. The exact amount of fault current, however, will depend upon the impedances of the several ground paths and the total fault current that is available. Air handlers for gas furnaces that are many years old seem to be the most prone. Typically, an inspection will show that the power for the blower motor on these older air handlers made use of a 2 conductor (i.e., non grounded) power cord.

A primary indicator that is found in these types of fires is the focal melting of the gas line at the connector. It is well known and appreciated that the flame that is fueled from a gas orifice does not normally make physical contact with the gas orifice; rather, there is some distance between the pressure, the size of the orifice, the available oxygen, and the mixing or turbulence. In short, the leaking gas is too rich to burn at the point of escape. In addition, gas that is under pressure will cause a very small amount of cooling to occur when the gas escapes from such a leak or orifice. Both of these factors indicate that a gas line would be least likely to melt at a connection if the melting were caused by the heat from the flame.

In the enclosed Photo 3, one can see that much of the polymer coating is still present on the gas line, and yet at the flare the brass has focal melting present. Testing of the polymer coating shows that it decomposes at temperatures of between 400 and 500 degrees F; brass requires temperatures of about 1700 degrees F before it will melt. Clearly, this type of damage cannot be from flame impingement. It is also noted that the brass flare is well protected from flame by the brass nut that definite lines of demarcation. In a distance of about 1/8", the heating of the arc will cause a transition to be made from melted brass to non-melted brass, and from no polymer coating (completely pyrolyzed) to an intact polymer coating. This rapid transition from extremely damaged (melted) brass to undamaged polymer is a very typical of an electric arc. Were the thermal damage caused by a flame, there would have been greater areas of heat stressing of the polymer coating.

In the cases described by the authors, the fire scene examination was usually straight forward and aided by the fact that fire destruction was not sever. Had the fire totally destroyed a building and its contents, the investigations would have been more difficult. Luckily, fires that destroy buildings usually leave externally pad-mounted air conditioning compressors intact. Checking of the windings for resistance and dielectric strength will help in diagnosing this type of fire. A blown fuse on a fused disconnect to a condensing unit is also an indicator of possible failure. Likewise, examination of the flared ends of the gas lines (inside the nuts) will also be helpful. The flared fitting should be relatively immune from actual melting from the fire unless the fire has reached temperatures in the 1700 degree F range. If the gas line is relatively unmelted, but the internal flare fitting is melted, one should suspect a fire brought on by arcing at the gas connection.

The authors have made no formal study of geographics regarding electrically induced gas fires, but common sense would indicate that this is more of regional phenomenon. One of the common causes of these types of fires is the electrical failure and breakdown of an air conditioning compressor. One would reasonably expect that such compressors would fail more often in hotter climates. Similarly, gas fueled fires will be more common in areas of the U.S. in which natural gas or LP gas are the prevalent sources of fuel for heating appliances.

Summation

The electrically induced gas fire is not particularly difficult to investigate *if* one appreciates the manner in which gas fittings are damaged by electrical current. These fires demonstrate the need for thorough examination of non-fire damaged equipment, such as air conditioning condenser units, after a fire. These types of fires can also mislead the investigator, given their possible multiple points of origin. Thorough electrical testing of the structure, documentation of the grounding system, and visual and microscopic examination of the gas fittings, can all be used in order to determine if this sequence of events is responsible for a fire's cause. ✧

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