D43 Did Radiant Heat From Electric Coils Cause a House Fire?

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After attending this presentation, attendees will better understand safety features in modern heating and cooling equipment and their applicability to a residential fire. Attendees will also gain an understanding of the importance of testing in forensic investigations.

This presentation will impact the forensic science community by highlighting the pitfalls of untested hypotheses in origin-and-cause investigations.

This case study involves a residential fire in southern West Virginia. A two-year-old heat pump serviced a double-wide manufactured home. The ducts and plenum boxes were replaced at that time in order to provide heated and cooled air to the home and one-story addition. On the date of the fire, the heat pump had stopped operating and the installer visited the home to return the unit to working order. Roughly 20 minutes after fixing the unit, a fire originated under the home, which eventually destroyed the structure.

An investigation was commenced by the homeowner's insurance company. The experts hired to perform the origin-and-cause investigation quickly determined that the fire started within the supply ducts near the heat pump. Particular attention was paid to the electric heating coils and control panel. The experts claimed that the unit was installed without thermal fuses, which are intended to shut off the second stage of heat when certain temperatures are reached. Additional installation deficiencies were identified, including insufficient duct diameter, improper filter, and inadequate fan setting. The homeowner had been notified of the fire by black smoke emanating from the floor registers. The experts demonstrated similar smoke by applying flames to the inner plastic jacket of the flexible ducts. The experts determined that the fire was caused by radiant heat from the electric heating coils. The experts hypothesized that the installation deficiencies allowed temperatures to rise to the point that the inner jacket of the duct ignited.

A separate origin-and-cause investigation was performed, which confirmed the area of origin. Initially, the experts' hypothesis seemed plausible, especially given the apparent lack of incendiary causes or other ignition sources near the area of origin; however, in order to adhere to the scientific method, all hypotheses must be tested in order to be confirmed as a theory. An equivalent heat pump was purchased and installed at this study's facilities. Additionally, the ducts and plenum boxes were reconstructed to depict airflow conditions at the subject home.

Several thermocouples were placed in critical areas in order to document the testing. Temperature readings were gathered near the electric heating coils, within the heating duct a few feet downstream of the discharge point, within the plenum box, and outside the unit to record ambient temperatures. In total, nine tests of the exemplar heat pump were performed. Normal operation of the unit resulted in peak temperatures of 220°F near the coils and 120°F in the supply duct. Subsequent tests involved progressive removal of safety components and increasingly obstructing airflow. Initial restrictions in the airflow caused temperatures to increase modestly; however, the electric heat sections cycled off, indicating proper function of the thermal switches.

As alleged by the other experts, the safety components were removed. Specifically, the high- and low-temperature switches were wired over, which caused continual operation of the electric heat section. Airflow restrictions were maintained to represent a worst-case scenario. Despite these efforts, temperatures stayed well below the ignition point for common plastics. Moreover, bypassing of the limit switches resulted in component failures on the control panel of the exemplar heat pump. Such component failures were not present during the origin-and-cause investigation of the subject heat pump. Air temperatures near the coils could have resulted in ignition of highly combustible materials, such as paper and dust. Such materials were introduced to the electric heat section. Although ignition occurred, the operation of the blower effectively snuffed out these small fires. None of the testing resulted in ignition of the duct liner.

The testing highlights the need for forensic engineers to fully test their hypotheses. While the opposing experts presented a compelling case, the application of the scientific method disproved their conclusions. Despite the fire occurring less than an hour after the heat pump was serviced, the installer was able to successfully defend his company against litigation. Although there are still uncertainties as to the exact cause of the fire, the allegations of installation and repair defects were disproved.

Radiant Heat, Electric Heating Coils, Ignition Temperature