



U.S. Forensic
Engineering • Inspection • Failure Analysis

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888-873-6752

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We provide structural, mechanical, and electrical engineering as well as accident reconstruction, fire origin and cause, and environmental services.

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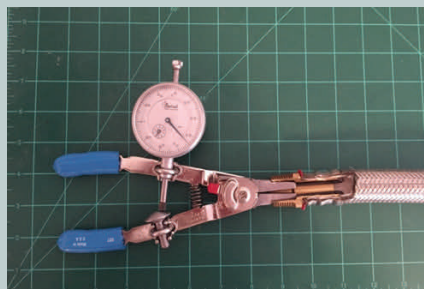
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Water Heater Connector Failures: An Engineering Assessment of Cause



National Forensic Engineering firm, U.S. Forensic, recently undertook a large project to investigate a large number of braided stainless steel water heater connector failures for one of the largest property carriers in the country. The evaluation and testing occurred at the U.S. Forensic engineering and testing laboratory where engineers utilized a customized durometer to test the hardness of the internal plastic tubing of the connectors and an articulating borescope to photograph any interior damage of the failed lines. Michael DeHarde, P.E. and Brian Darr, P.E. worked on the months-long project to determine the cause of the leaks associated with the braided stainless steel brand water heater connectors commonly sold at the major big box hardware centers.

U.S. Forensic was one of several forensic engineering firms approached to work on the project. U.S. Forensic was selected based in part on the proposal to actually test each unit and photograph the results of the test, rather than just inspect visually, as proposed by others. As NASA Rocket Scientist Wernher von Braun famously said “One test result is worth one thousand expert opinions.”



Custom made durometer and cross sectioned exemplar connector

using a high end articulating borescope to document the failure region.

An exemplar connector was cross sectioned to understand the interior make up of the hose and to assist in the design and manufacture of a custom made durometer that could perform the task of measuring the hardness of the plastic interior materials. The durometer was first tested in an exemplar connector. Then, each reportedly failed hose was visually inspected on the exterior and in the interior. They were also measured and photographed both externally and internally to document what was present in and on the hose upon receipt. The location and cause of the leak was observed and then photographed internally

After analyzing multiple connectors of differing sizes, most being 12, 18 and 24 inches in length with 3/4 inch female fittings on either end, the findings were consistent. The leaks, as many online had speculated, were not related to the fittings. **U.S. Forensic, through their testing, revealed that the leaks were present within the inner plastic tubes and were the result of the inner plastic tubes prematurely decomposing and flaking apart. This material defect led to a breach of the internal wall which caused the water release and the resultant damages at the various properties across the country.**

In some cases, U.S. Forensic was supplied with the other water heater connector which had not failed but had been removed from the water heater. While the second connector showed some changes, this second connector did not have the extensive level of degradation found on the failed connector. This provided valuable information. While in most cases we were not provided the identity of whether the connector was either hot or cold connector, U.S. Forensic believes that the failed connectors were primarily the hot water, or outgoing, connectors. A rule of thumb, when dealing with plastic, for every 10 degrees Celsius of temperature rise, the chemical reaction rate doubles.

This manufacturing or design defect in many cases ultimately caused the braided stainless steel housing of the connectors to cave in, deform, and/or twist. It was determined that a chemical reaction caused the plastic tubing in the connectors to decompose, and this decomposition caused the connector to structurally deform. Additional information regarding the materials used and the manufacturing process received will provide insight as to the chemical process involved in the decomposing process and the root cause of the defective product.

U.S. Forensic understands that codes and industry standards don't always address the needs of a good scientific investigation to determine root cause failure analysis. While the ASME A112.18.6 Flexible Water Connectors 4.3 Hydrostatic Burst Test: Connector recommends the connectors should be pressurized at 250 psi at 180OF and held at that pressure and temperature for 0.5 hours, it does not address or test for long term creep in plastic. U.S. Forensic is constantly developing new tools and procedures to push forward the envelope of product liability failure analysis. U.S. Forensic engineers now hold 3 patents, were responsible for 2 national manufacturer vehicle service campaigns, helped author the new ASHRAE standard for air conditioning flexible duct installation procedure. Stay tuned for the results of U.S. Forensic testing on various plumbing connectors that more closely mimic real world conditions of connectors and a laboratory recreation of these water connector failures.



Internal borescope image revealing the decomposition of the interior plastic tubing.