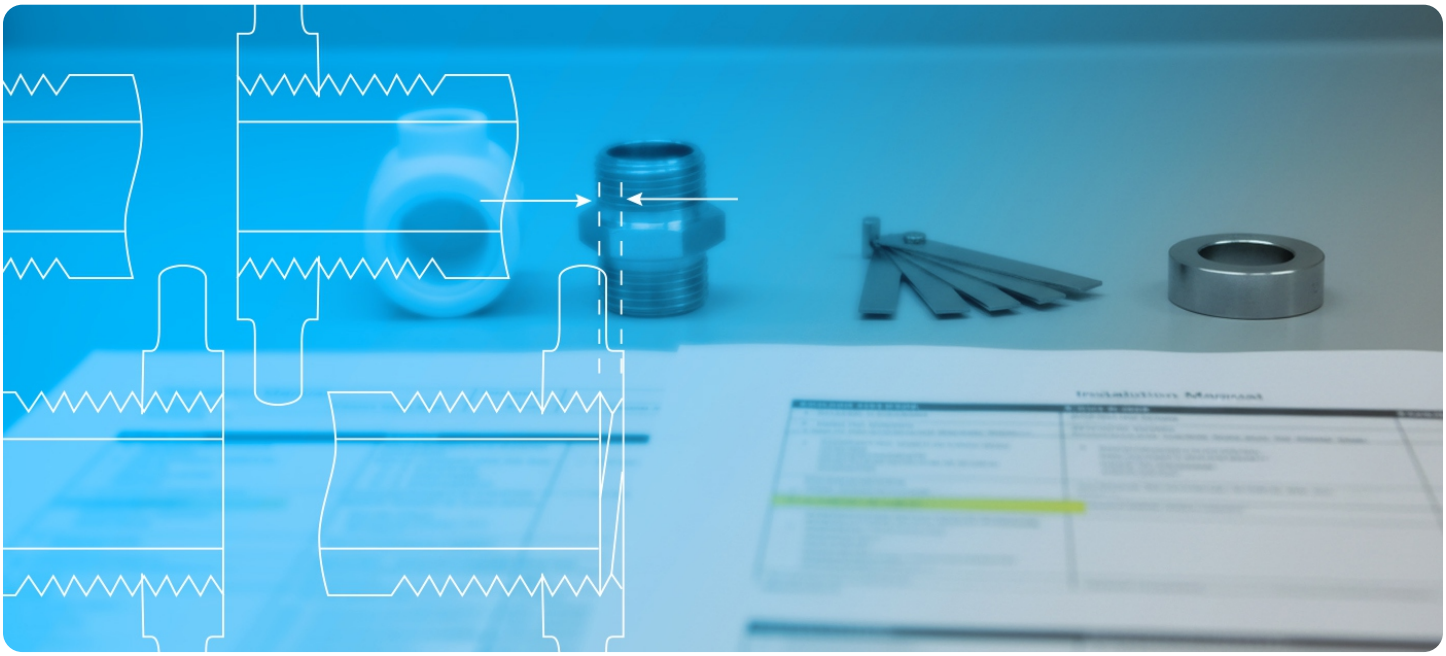


PVC Plastic Threaded Fitting Failure Analysis

Engineering analysis determined yacht sinking resulted from improper installation practices, not manufacturing defects.

The Situation

A 43-foot luxury yacht experienced partial sinking due to water intrusion caused by catastrophic failure of a PVC plastic threaded fitting in the live baitwell pump assembly. The PVC internally threaded fitting was connected to an externally (male) threaded metal fitting. The PVC fitting failed by a longitudinal crack that developed at the connection.

Opposing experts alleged the failure resulted from manufacturing defects in both the plastic fitting (weak weld line) and metal check valve (improper thread dimensions). ESi was retained to conduct an independent investigation and provide expert testimony regarding the root cause of the PVC fitting failure.

Our Approach:

ESi conducted a comprehensive failure analysis investigation combining materials science, mechanical testing, and standards compliance testing. The investigation began with detailed visual documentation and systematic disassembly of the failed pump assembly to preserve evidence and understand the installation configuration. This was followed by microscopic examination of fracture surfaces using both optical and scanning electron microscopy (SEM) to identify failure mechanisms at multiple magnifications.

ESi Consultants:

Anand Shah
Principal and Director

Gaurav Nagalia,
Senior Consultant

Services Utilized:

- Failure Analysis
- Materials Testing

Our Approach *cont*

Fracture surface analysis revealed critical evidence of crack initiation patterns and propagation mechanisms that was consistent with time dependent creep-rupture failure mode, indicating sustained stress over time rather than sudden overload. ESi employed Energy Dispersive Spectroscopy (EDS) to determine elemental composition of the metal component while using Fourier Transform Infrared Spectroscopy (FTIR) to confirm the material identification of the plastic fitting and verify it met material specifications. ESi also performed stress analysis calculations to determine the hoop stress levels generated during installation and how they compared to the material's long-term strength capabilities.

The team conducted precise thread measurements using calibrated pitch gages and industry-standard ring gages to verify compliance with ANSI/ASME B1.20.1 specifications for tapered pipe threads. Opposing experts claimed improper thread dimensions was the cause of the failure. However, ESi's SEM analysis showed that thread flats contain manufacturing burrs, making caliper measurements inherently inaccurate. This meticulous dimensional analysis was critical to evaluating the opposing experts' claims and ultimately determined that the opposing experts had fundamentally misinterpreted ANSI B1.20.1 threading standards.

Our investigation included comprehensive review of industry codes, installation manuals, and engineering standards to establish proper installation practices for connecting plastic and metal threaded fittings. ESi analyzed the installation torque requirements and compared them against the failure stress thresholds for PVC materials. The team also reviewed best practices from plumbing codes and marine industry standards that specifically address the risks of over-tightening plastic fittings.

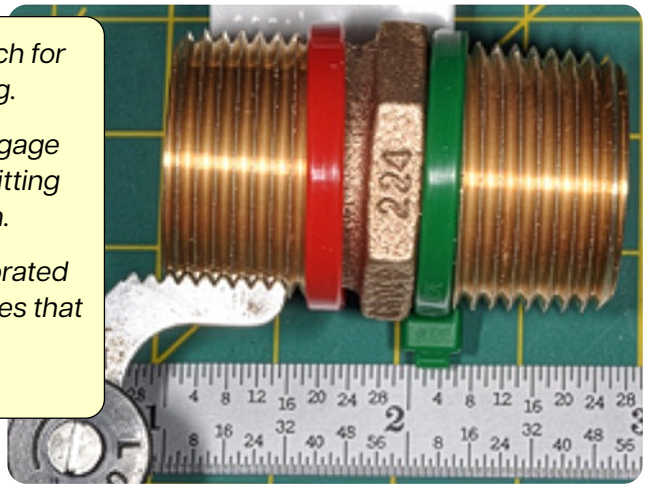
The Outcome

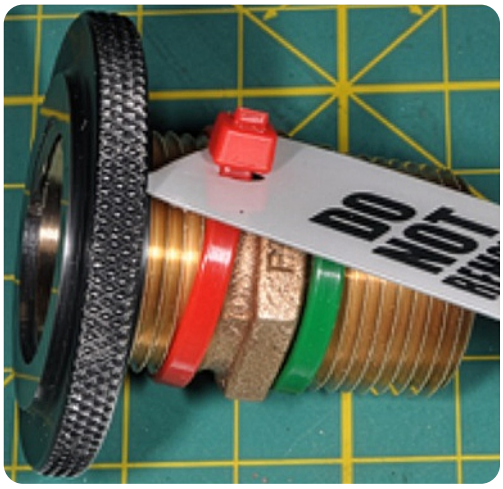
ESi's investigation demonstrated that the yacht sinking resulted from improper installation practices rather than component manufacturing defects. The analysis proved that over tightening a male-threaded metal fitting to a female-threaded plastic fitting violates established industry standards and creates excessive hoop stress leading to predictable failure. ESi found fundamental errors in measurement techniques and standard interpretation in the opposing experts' investigation.

The correct approach for assessment of fitting.

(Left) Use of a pitch gage demonstrates that fitting had 14 threads/ inch.

(Right) Use of a calibrated L1 gage demonstrates that fitting met NPT specification.





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