Alternative to Nagging Fu

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On the other side of the world, engineers aboard a Royal Australian Navy (RAN) ship had grown tired of those nagging little fuel leaks you always get with rigid piping. So, they decided to take matters into their own hands. They hired a contractor to replace all the fuel piping on the main diesel engines. The contractor installed flexible hoses made of Teflon and reinforced with a braided, steel-wire exterior.

Everything was OK until the ship headed out of a harbor with both main engines operating. Pressure pulses in the engine supply-and-return lines began to stress the flexible hoses. Soon, a hose supplying fuel to the port main engine ruptured, spraying fuel into the space. Watchstanders quickly secured this engine and isolated the leak. Unknown to them, however, a hose on the starboard main engine also had ruptured.

The fuel spray from the starboard engine soon burst into flames and created every engineer's nightmare—a fuel fire in the main-machinery space. The fire quickly grew out of control, and the space filled with heat and smoke, forcing watchstanders to evacuate. It took firefighters three hours to extinguish the inferno, which killed four people. *(For complete details, see "A Tough Decision" in July-September 1999 issue.)*

What went wrong? The Teflon hoses used to replace the fuel piping were not designed to withstand the pressure pulses that occur in the supply-and-return lines of engines. The constant stress of the pressure pulses caused the hoses to weaken and eventually fail.

How could this happen? Ship's force hadn't submitted an alteration request to change the hard piping to flexible hoses on the diesel engines. Without RAN approval, the alteration was unauthorized. To make matters worse, the hoses used by the contractor were not RAN-approved, and ship's

Navy photo by PH2 Felix Garza

Rigid piping, such as you find on this gas-turbine engine a Sailor is working on, may develop nagging little fuel leaks. The answer, however, is not to replace the piping with flexible rubber hoses.

el Leaks Can Be a Killer

force didn't check the hoses before the contractor installed them.

After reading about this disaster, I did some research and learned there have been many recent changes to the application, life cycle and criticality of flexible hoses in the U.S. Navy. It's important that we understand the new requirements so we don't repeat the mistakes that led to the deaths of those four Australian sailors.

Teflon flexible hoses (like the ones the contractor used aboard the RAN ship) are authorized for steam drains (below 380 degrees). They also are OK to use for compressed air (low and high pressure up to 350 degrees), nitrogen (low and high pressure up to 350 degrees), and oxygen (permitted only for charging purposes from pier to ship).

The benefit of using Teflon flexible hoses is that service conditions usually won't degrade them, which ensures unlimited service life. Consider Teflon hoses as replacements for critical rubber hoses reaching the end of their service life or failing inspection. Once in place, Teflon hoses only require replacement if they fail periodic inspection.

The life cycle of flexible rubber hoses involves two elements: shelf life and service life. The shelf life is from the date of manufacture (which should be marked on the hose) to installation. The basic shelf life is six years. If the hoses are stored properly, their shelf life can be extended four years, at two-year intervals, provided they pass the required tests[1].

The service life of rubber hoses starts when we install them. The length of service life is determined by the criticality of the system or application in which we use them. Rubber hoses in critical systems and applications have a maximum service life of 12 years, at which time we must replace them. Hoses placed in non-critical applications have no limits to service life. Flexible rubber hoses (critical or non-critical) that are used in vacuum service and that are immersed in water have a maximum service life of six years. All flexible hoses require periodic inspection[2]. Immediately replace any hoses that fail inspection or show signs of leakage.

Flexible hoses are critical if we use them in any of these systems or applications:

- mission essential, where failure would jeopardize a ship's mission
- ship safety, where failure would affect a ship's safety systems
- hazardous fluid, where failure would release a system fluid that injures people or damages equipment
- hazardous pressure, where systems have design pressure greater than 1,000 psi for gas or 500 psi for fluid
- collateral damage, where failure of a hose would cause damage to equipment
- repair capability, where ship's force is not capable of repairing a hose assembly at sea.

All other flexible hoses are considered non-critical. Each ship must submit a list of critical and non-critical hoses to Naval Sea Systems Command for approval. Until the list is approved, the maximum service life of flexible rubber hoses is 12 years.

Ship's force must ensure flexible hoses are used in the proper applications, even when outside activities do the repairs. Determining criticality and understanding the system requirements are important steps to getting the right flexible hoses in the right systems. The consequences of a mistake can be a disaster like the one that occurred aboard the RAN ship.

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For More Info...

[1] Naval Sea Systems Command Technical Directive S6430-AE-TED-010 (Piping Devices, Flexible-Hose Assemblies) outlines the tests that flexible rubber hoses must pass before their shelf life can be extended.

[2] S6430-AE-TED-010 also details the inspection schedule for all flexible rubber hoses.