

4.8 Normally-Closed Zero Leak Valve

Statement: Pyrotechnic valves are replaced with magnetostrictive valves.

Problem: The pyrotechnic valve is currently the only zero-leak valve qualified for spaceflight in the U.S. aerospace industry. The pyrotechnic valve design can have reliability issues. Pyrotechnic valves are one-time-use and individual units cannot be tested for functionality. A need exists for a valve that provides a zero-leak seal using a safer, more reliable actuator with a verifiable function.

Solution: The valve utilizes the magnetostrictive alloy Terfenol-D for near instant actuation. Terfenol-D undergoes magnetostriction, or gross elongation, when exposed to a magnetic field. This fractures the seal and opens the valve permanently to establish fluid flow.

Technology description: The valve consists of two major sub-assemblies: the actuator and the flow cavity. The actuator is preloaded to 1,250 N by adjusting the preload bolt, pressing the Terfenol-D against the now-deflected Belleville springs. When actuation is needed, a solenoid coil is charged in a pulsed mode, causing magnetostriction or elongation in the Terfenol-D which deflects the Belleville spring stack, supplying an increasing load to the stem until the parent metal seal is fractured. Once fractured, the spring inside the bellows drives the bellows base downward, onto a raised boss at the top of the fracture plate. When a fracture has occurred, the stem and its spring stack is left, separated from the actuator column. The Terfenol-D is unloaded and returns to its original length. The valve remains open due to the spring inside the bellows.

Benefits of the product: This technology has potential where reliable emergency valve actuation is required.

- Non-pyrotechnic and non-explosive, and thus safer than currently used pyrotechnic valves.
- Serviceable and repairable in-situ.
- Can be electrically tested end-to-end.
- Survivable temperature range of -73°C to +93°C.
- Offers well timed, near instant actuation.

Areas of application: Fluid isolation and all other applications wherever normally-closed valves are used, including chemical plant and oil and gas industry.