The University Of Sheffield.

Advanced Manufacturing Research Centre

Pyro Valve replacement concept

Initial concept generation sessions were undertaken at the AMRC DPG. A large number of ideas were generated covering all of the topics identified in the competition brief. These ideas were down selected to the two options short-listed for presentation at the final.

The pyro-valve replacement idea began as a magnetically operated valve. The initial idea took inspiration from magnetically operated valves in the automotive industry, which use stacks of opposing magnets to form valve springs. Exploration of this idea generated a range of possible solutions.

Some simple calculations were used to refine the ideas, by comparing their theoretical performance against that of the 'standard' pyrotechnic valve. These calculations suggested that to equal the actuation force of the pyrotechnic charge, the number of permanent magnets would be too large to be practical. Similarly, electromagnets would be an issue due to the size, weight and power requirements. Other options were investigated and dismissed due to their limited performance. A simple mechanical spring was selected as the solution of choice due to its compact size, high availability, and wide range of forces available. Combining this mechanical spring with a piezo electric trigger mechanism was selected as a suitable option for a valve package.

The proposed setup and arrangement of the elements creates a passive interference fit between the trigger elements and the valve slider. Power applied to the elements would eliminate this interference fit through the distortion of the elements. The removal of the interference fit would allow the valve slider to move under the applied load of the compressed spring. Post trigger and actuation, upon removal of the power to the elements, they would return to their original positions, reinstating the interference fit. With correct design of the valve slider, the interference fit will lock the valve in its final resting position permanently. Assembly and testing options for the trigger mechanism were explored as major advantages in safety and reliability over standard pyrotechnic charges for actuation.

The careful arrangement of the elements could allow for trigger redundancy; a minimal number of working actuators would be required to trigger the valve. This would allow for multiple fall-back trigger options, increasing reliability of the valve. No moving parts in the actuators and the solid state nature of the electronic systems would reduce the chance of failure over mechanical trigger options.