



TECHNOLOGY SOLUTION

Robotics, Automation and Control

Cooperative Service Valve for In-orbit Cooperative Satellite Fueling

Enables tele-robotic operated resupplying of media (such as propellants and pressurant) to cooperative satellites.

NASA Goddard Space Flight Center has developed the Cooperative Service Valve (CSV) to facilitate the resupply of media, such as propellants and pressurants, to satellites. The CSV replaces a standard spacecraft fill and drain valve. Spacecraft outfitted with the CSV enable in-orbit servicing with less risk, lower costs, and a much higher chance of success. The tools used to interface with the CSV, both on the ground and in space, were also designed and tested by NASA.

The CSV architecture and approach is extensible to all space assets that could potentially be fueled/re-fueled on and off the ground, including manned crew vehicles, planetary rovers, and space habitats.

BENEFITS

- Designed for human and robotic access
- Replaces standard fill and drain valves
- Requires no caps or wires
- Inherent thermal isolation
- Compatible with common spacecraft propellants and pressurants including xenon
- Self-locking against inadvertent actuation
- Similar in size to standard valves
- 2-fault tolerant to leakage when closed, 1-fault tolerant to leakage during fueling



THE TECHNOLOGY

The CSV replaces a standard spacecraft Fill and Drain Valve to facilitate cooperative servicing. The CSV offers various advantages over standard service valves: a robotic interface, three individually actuated seals, a self-contained anti-back drive system, and built-in thermal isolation. When mounted to a spacecraft as designed, the CSV transfers all operational and induced robotic loads to the mounting structure. An anti-back drive mechanism prevents the CSV seal mechanism from inadvertent actuation. Alignment marks, thermal isolation, and a mechanical coupling capable of reacting operational and robotic loads optimize the CSV for tele-robotic operations. Unique keying of the mating interface prevents mixing of media where more than one configuration of the CSV is used. Color-coding and labels are also used to prevent operator error.

The CSV has four configurations for different working fluids, all with essentially unchanged geometry and mechanics.

Configuration	-301	-303	-305	-307
<i>Working Fluid</i>	Pressurant (He, Xe, other)	Hydrazine (N ₂ H ₄)	MMH	NTO
<i>Operating Pressure (psig)</i>	3000	650	650	650
<i>Proof Pressure (psig)</i>	4500	975	975	975
<i>Design Burst Pressure (psig)</i>	7500	1625	1625	1625
<i>Min. Flow Rate</i>	9.62 SFCM GHe	10 lbm/min H ₂ O	10 lbm/min H ₂ O	10 lbm/min H ₂ O
<i>Mass (kg)</i>	0.27	0.27	0.27	0.27
<i>Leakage Rate (sscs GHe)</i>	< 1X 10 ⁻⁵	< 1X 10 ⁻⁵	< 1X 10 ⁻⁵	< 1X 10 ⁻⁵

APPLICATIONS

The technology has several potential applications:

- Ground and launchpad fueling
- In-space satellite refueling and repair (commercial, government, military)

PUBLICATIONS

Patent No: 10604281

National Aeronautics and Space Administration

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