

ABSTRACT

An adaptive maintenance cartridge autonomously corrects anomalies in mission-critical subsystems. Each cartridge houses a consumable medium—such as a filter, sealant, phase-change material, corrosion inhibitor, additive, anodic metal, or sorbent—plus sensors that detect contamination, thermal spikes, corrosion, fuel dilution, electrostatic charge, or micrometeoroid puncture. A controller analyzes sensor data, meters the consumable to close the anomaly, verifies success, and logs cartridge status on the host platform's data bus. Representative embodiments include:

- a high-pressure hydraulic filter with additive dosing for combat aircraft;
- a self-healing sealant tile for spacecraft hulls;
- a cryogenic propellant-quality module for launch umbilicals;
- a duplex corrosion-inhibitor for naval seawater lines;
- a phase-change thermal cartridge for satellites and high-altitude UAVs;
- a conductive-mist ESD neutralizer for satellite electronics; and
- an engine-oil purifier for armored-vehicle powerpacks.

The cartridges deliver real-time corrective action, cut unscheduled maintenance, extend component life, and reduce hazardous-waste generation across air, sea, land, and space platforms.