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## Propulsion Subsystem

The propulsion subsystem provides the means for attitude and orbit control (AOC) and the incremental velocities at apogee required for orbit raising and final injection into geostationary orbit. The subsystem consists of one 490-N (110-lb) apogee thruster and twelve 22-N (5-lb) attitude and orbit control thrusters, using liquid bipropellants — about 694 kilograms (1530 pounds) of nitrogen tetroxide ( $N_2O_4$ ) and 431 kilograms (950 pounds) of monomethyl hydrazine (MMH). These propellants are contained in two spherical titanium tanks pressurized by helium (He) supplied from a single tank.

The 490-N apogee thruster is a restartable unit designed for a minimum of three apogee maneuver firings (AMFs). During AMF, six AOC thrusters provide attitude control. The apogee thruster consists of two high-response, integral solenoid-operated valves; a thrust chamber with a 164:1 expansion area ratio nozzle; and an injector assembly.

Six of the 12 AOC thrusters are primary with the remaining six acting as backup for complete thruster redundancy. The six thrusters supply the control torques necessary to maintain proper spacecraft orientation during apogee motor firing and subsequent sun and earth acquisition maneuvers. They also support stationkeeping and on-orbit control throughout the mission.

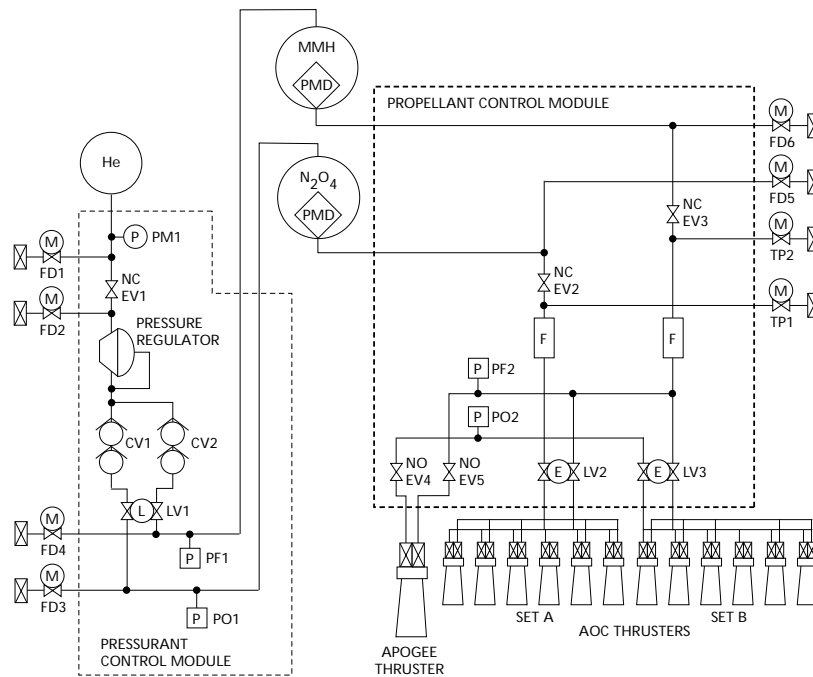
After apogee maneuvers are completed, the propulsion subsystem is operated in a blow-down mode for the remainder of the mission. A surface tension propellant management device (PMD) in each propellant tank controls the location of propellant in the zero-gravity space environment. This device enables bubble-free propellant to be supplied to the tank outlet for all thruster firings throughout the spacecraft's operational life. The stainless steel lines distributing propellant from each tank to each set of six AOC thrusters use latching isolation valves that can isolate either redundant branch of the thrusters in the event of a thruster failure, thruster valve leakage, or failed on signal. The valves are selectable by ground command for either manual closure or automatic closure by the attitude and orbit control subsystem should it detect a failure (for example, thruster remaining activated beyond a predetermined time period).









Most of the subsystem's components are mounted on the propulsion module, which is built around the central structural thrust tube. The 103-centimeter (40.6-inch) diameter spherical propellant tanks are mounted in the tube while the high pressure helium tank is externally mounted on the central thrust tube. The 490-N apogee thruster is mounted to the west end of the structure as opposed to the twelve 22-N AOC thrusters, which are hard-mounted to the central structure by brackets and panels for alignment stability. Four pitch and yaw thrusters are mounted on the east end and four others on the west end. Four roll thrusters are mounted on the south panel.

The operations required in geostationary orbit to control the spacecraft over its mission life are performed by the 22-N AOC thrusters. These operations include:

- Sun acquisition and attitude maintenance
- Earth acquisition
- Attitude control during apogee thruster firing
- Momentum wheel spinup control
- Apogee dispersion correction
- North/south stationkeeping
- East/west stationkeeping
- On-orbit attitude control operations
- Station change (relocation in geostationary orbit)
- Boost from geostationary orbit at end of life

**Propulsion Subsystem Schematic**



Legend			
AOC	Attitude and Orbit Control		Dual Check Valve
MMH	Monomethyl Hydrazine		NC Normally Closed Pyro Valve
PMD	Propellant Management Device		NO Normally Open Pyro Valve
	Filter		P Low-Pressure Transducer
	Manual Valve		P High-Pressure Transducer
	Biprop Latch Valve		

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### Propulsion Subsystem Components



Propellant Tank



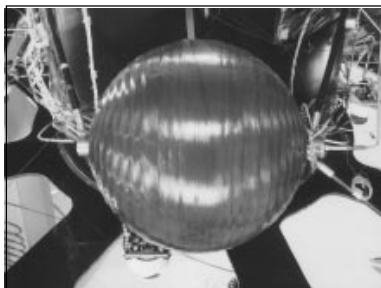
Apogee Thruster



AO Thruster



Fill and Drain Valve

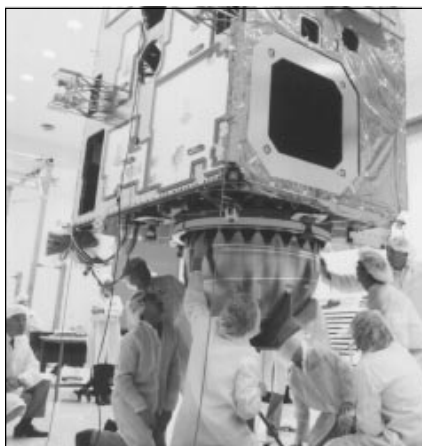


Helium Pressurant Tank

### Propellant Tank Installation



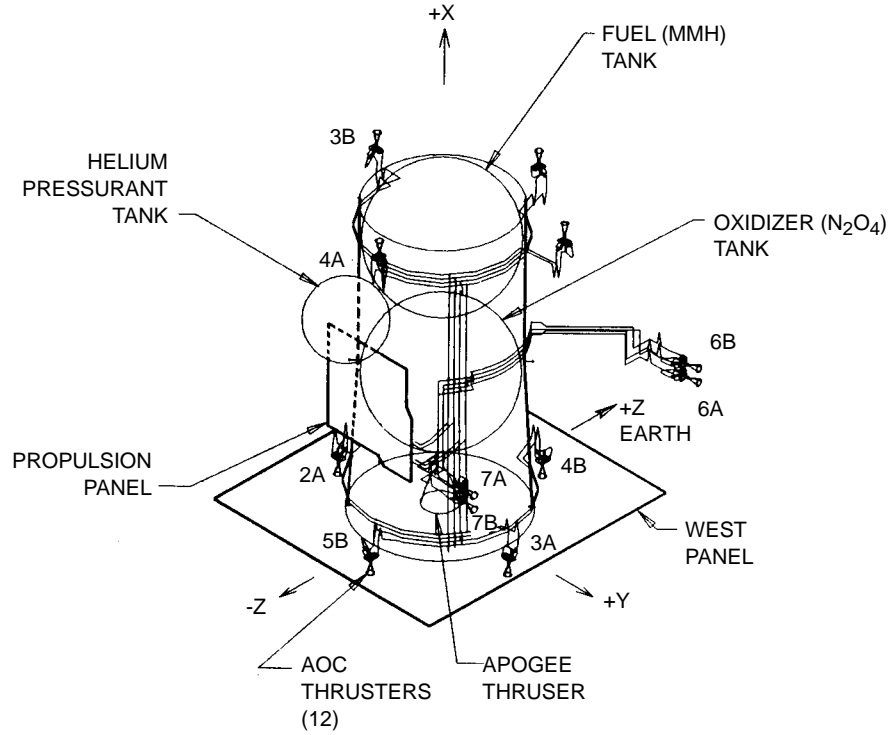
Fuel (Monomethylhydrazine) Tank



Oxidizer (Nitrogen Tetroxide) Tank

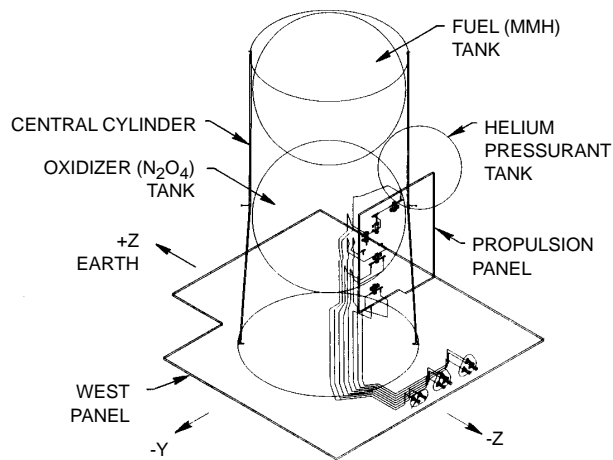


### Propulsion Subsystem Thruster Line Routing



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### Propulsion Subsystem Fill/Drain Valve Line Routing



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