

## **Adjustable Liquid Regulator Design & Development**

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AIAA JPC&E 2002 Paper abstract

A passive mechanical regulator has been developed for the control of fuel or oxidizer flow to a 450N class bipropellant engine for use on commercial and interplanetary spacecraft. The main advantage of this regulator over other units available in the market is that its regulation set point can be changed in flight  $\pm 4\%$  about a nominal point, and then it can regulate about that set point to within  $\pm 0.75\%$ . The set point change is handled actively via a stepper motor driven actuator, which converts rotary into linear motion to affect the spring preload acting on the regulator. Once adjusted to a particular set point, the actuator remains in its final position unpowered, and the regulator passively maintains outlet pressure.

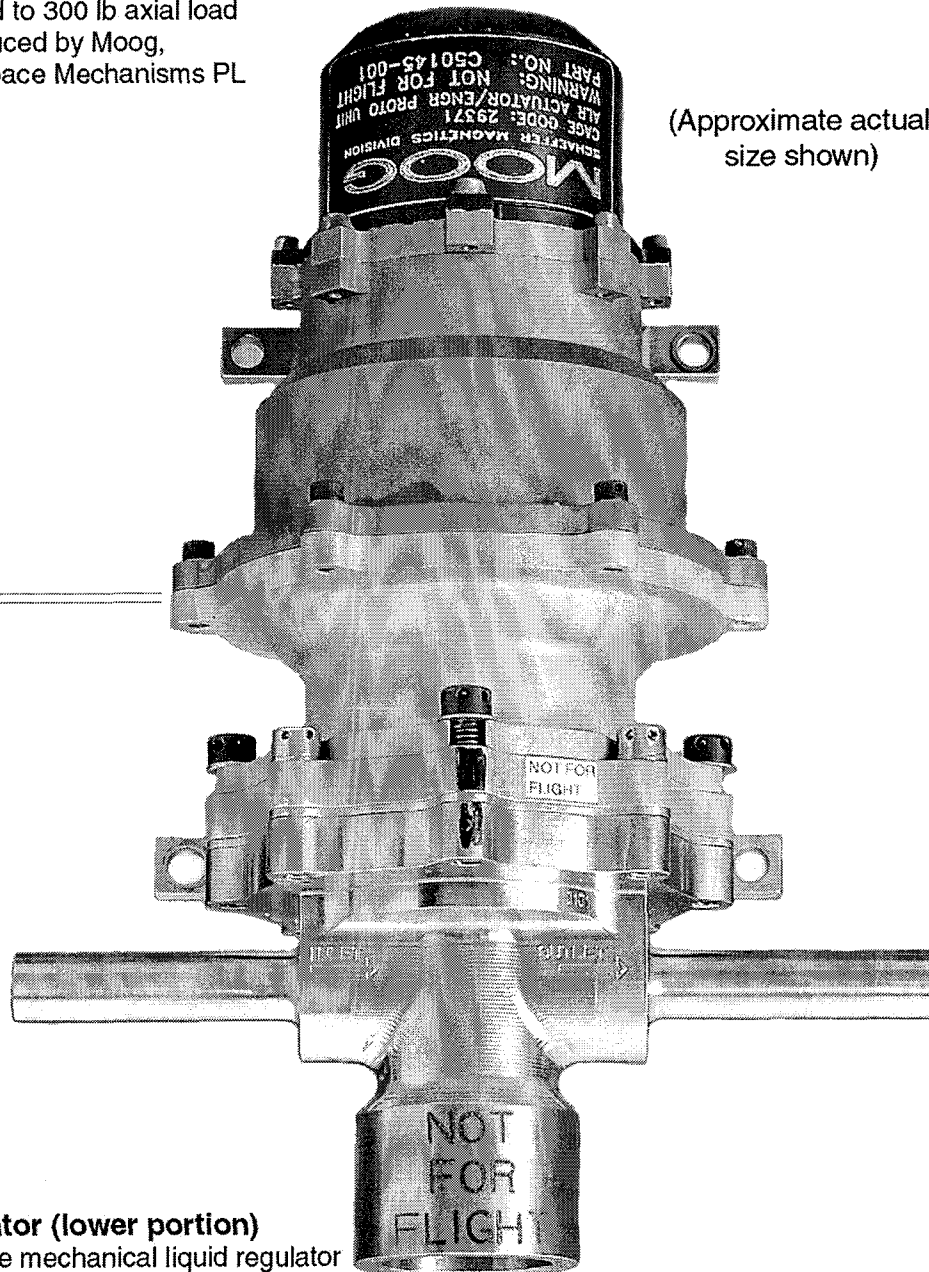
The very precise outlet regulation pressure is possible due to new technology developed by Moog, Inc. which reduces typical regulator mechanical hysteresis to near zero. The requirements for the unit developed specified a set point range from 225 to 255 psi, and equivalent water flow rates required were in the 0.17 lb/sec range. The regulation output pressure is maintained  $\pm 2$  psi about the set point from a delta P of 20 to over 100 psid. Maximum system pressure was specified at 320 psi. The regulator is fault tolerant in that it was purposely designed with no shutoff capability, such that the minimum flow position of the poppet still allows the subsystem to provide adequate flow to the main engine.

## Adjustable Liquid Regulator (ALR) Developed for JPL (1999-2001)

**MOOG**

### Stepper Motor Actuator (top portion)

Stepper motor combined with a 100:1 harmonic drive  
0.080 total linear output travel  
28 volt nominal supply  
25 millionths linear output per rotary step  
tested to 300 lb axial load  
Produced by Moog,  
Space Mechanisms PL



(Approximate actual  
size shown)

### Regulator (lower portion)

Passive mechanical liquid regulator  
0.17 lbm/sec equivalent water flow  
Operating fluids: NTO, Hydrazine, MMH  
Patent pending technology reduces spring system hysteresis to near zero  
Output regulation  $\pm 2$  psi about setpoint over 20 to 110 psid  
Regulator set point adjusted by actuator from 225 to 255 psi  
Produced By Moog, Space Fluids PL