



## PROPELLANT TANK PVT QUANTITY GAUGING

### SUMMARY

Due to the inherent inaccuracies of flight-type propellant gauging systems, the White Sands Test Facility (WSTF) has demonstrated the capability to determine the liquid level in a propellant tank by means of a pressure, volume, and temperature (PVT) application that uses monomethylhydrazine (MMH) as the liquid.

### TEST APPARATUS AND PROCEDURE

The PVT application is set up for gauging the level of liquid in a propellant pressure vessel (tank) via two methods.

The first method is the ullage compression method (UCM). The level of liquid in the propellant tank is determined after adding a known delta volume of liquid to the tank without venting the ullage pressure. A real-time algorithm uses the known delta MMH volume added, the delta temperature, and the delta pressure of the tank ullage to calculate the volume of the tank ullage. The level of the liquid is determined from the remaining volume in the propellant tank.

The second method is called the external helium tank method (EHTM) and uses an external helium tank that is pressurized and connected to the propellant tank but is initially isolated from the tank. Starting with stable pressures and temperatures in both tanks, the pressurized helium tank is opened to the propellant tank until the pressures and temperatures stabilize. The volume of the propellant tank ullage is calculated from the delta pressures and temperatures in the tanks.

The level of the liquid is then determined from the remaining volume in the propellant tank.

For both methods, the use of a real-time algorithm takes into account the following caused by delta pressure and temperature of the ullage, the propellant tank skin, and the liquid:

- Expansion of the propellant tank and helium tank
- Vapor pressure of the liquid (MMH)
- Volume expansion of the liquid (MMH)

### INSTRUMENTATION

The real-time calculation uses the following set of instrumentation to obtain the best accuracy:

- Seven type-T thermocouple probes in the ullage ( $\pm 1$  °F)
- Eight type-T thermocouple skin patches ( $\pm 1$  °F)
- Two pressure transducers (0.05 percent F.S.)

The external helium tank has:

- Twelve type-T thermocouple internal probes ( $\pm 1$  °F)
- Four resistance temperature detector (RTD) internal probes ( $\pm 1$  °F)
- Two pressure transducers (0.05 percent F.S.)





## TEST RESULTS

Using all of the instrumentation, the real-time algorithm calculation has the best accuracy in a reasonable stabilization period. The accuracy tends to improve with greater compressions for both the UCM and EHTM when verified with x-rays of the liquid level in the propellant tank.

## CONTACT

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