# Technology Focus: Test & Measurement

## Cryogenic Chamber for Servo-Hydraulic Materials Testing

*Goddard Space Flight Center, Greenbelt, Maryland*

A compact cryogenic test chamber can be cooled to approximately 5 to 6 Kelvin for materials testing. The system includes a temperature controller and multiple sensors to measure specimen temperature at different locations. The testing chamber provides a fast and easy method to perform materials testing at lower than liquid nitrogen temperature (77 K). The advantage of this chamber is that lower than 77 K temperatures are achievable, and the temperature can be controlled and stabilized during a test.

The purpose of the chamber is to cool a composite lap shear specimen to approximately 20 K so that tensile test force and displacement data may be acquired at this cryogenic temperature range. Other specimens of similar size and possibly different geometry can also be tested using the same technique with minimal chamber modification.

The chamber is constructed from commercially available supplies and materials. A copper pipe is capped at the ends, allowing a segment of the specimen to pass through each side and attach to a tension-testing machine. A coil of tubing wraps around the outside to allow cooling with cold gas from the end of a transfer line that is inserted into liquid-helium supply dewar. The transfer line feeds liquid helium into the tube coil of the chamber through a gas-tight quick-connect fitting. The cold helium gas cools the chamber and flows inside the chamber to cool and exchange heat before venting through the outlet. The inlet and outlet lines are thin-walled stainless-steel tubing that traverses a thick layer of high-performance insulation. Stainless-steel wire is adhered with epoxy to the outer chamber wall and functions as a heater for temperature control. The temperature of the chamber and specimen are monitored, and a standard PID (proportional–integral–derivative) control is applied to the heater circuit to regulate temperature.

*This work was done by John J. Francis and James Tuttle of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15694-1*

## Apparatus Measures Thermal Conductance Through a Thin Sample From Cryogenic to Room Temperature

*Goddard Space Flight Center, Greenbelt, Maryland*

An apparatus allows the measurement of the thermal conductance across a thin sample clamped between metal plates, including thermal boundary resistances. It allows *in-situ* variation of the clamping force from zero to 30 lb (133.4 N), and variation of the sample temperature between 40 and 300 K. It has a special design feature that minimizes the effect of thermal radiation on this measurement.

The apparatus includes a heater plate sandwiched between two identical thin samples. On the side of each sample opposite the heater plate is a cold plate. In order to take data, the heater plate is controlled at a slightly higher temperature than the two cold plates, which are controlled at a single lower temperature. The steady-state controlling power supplied to the hot plate, the area and thickness of samples, and the temperature drop across the samples are then used in a simple calculation of the thermal conductance.

The conductance measurements can be taken at arbitrary temperatures down to about 40 K, as the entire setup is cooled by a mechanical cryocooler. The specific geometry combined with the pneumatic clamping force control system and the steady-state temperature control approach make this a unique apparatus.

*This work was done by James G. Tuttle of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15698-1*

## Rover Attitude and Pointing System Simulation Testbed

*NASA's Jet Propulsion Laboratory, Pasadena, California*

The MER (Mars Exploration Rover) Attitude and Pointing System Simulation Testbed Environment (RAPSSTER) provides a simulation platform used for the development and test of GNC (guidance, navigation, and control) flight algorithm designs for the Mars rovers, which was specifically tailored to the MERs, but has since been used in the development of rover algorithms for the Mars Science Laboratory (MSL) as well.

The software provides an integrated simulation and software testbed environment for the development of Mars rover attitude and pointing flight software. It provides an environment that is able to run the MER GNC flight software directly (as opposed to running an algorithmic model of the MER GNC flight code). This improves simulation fidelity and confidence in the results. Furthermore, the simulation environment allows the user to "single step" through its execution, pausing, and restarting at will. The system also provides for the introduction of simulated faults specific to Mars rover environments that cannot be replicated in other testbed platforms, to stress test the GNC flight algorithms under examination.

The software provides facilities to do these stress tests in ways that cannot be done in the real-time flight system testbeds, such as time-jumping (both forwards and backwards), and introduction of simulated actuator faults that would be difficult, expensive, and/or destructive to implement in the real-time testbeds. Actual flight-quality codes can be incorporated back into the development-test suite of GNC developers, closing the loop between the GNC developers and the flight software developers. The software provides fully automated scripting, allowing multiple tests to be run with varying parameters, without human supervision.

*This work was done by Charles A. Vanelli, Jonathan F. Grinblat, Samuel W. Sirlin, and Sam Pfister of Caltech for NASA's Jet Propulsion Laboratory.*

*This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-46288.*

# Desktop Application Program To Simulate Cargo-Air-Drop Tests

*Lyndon B. Johnson Space Center, Houston, Texas*

The DSS Application is a computer program comprising a Windows version of the UNIX-based Decelerator System Simulation (DSS) coupled with an Excel front end. The DSS is an executable code that simulates the dynamics of airdropped cargo from first motion in an aircraft through landing. The bare DSS is difficult to use; the front end makes it easy to use. All inputs to the DSS, control of execution of the DSS, and postprocessing and plotting of outputs are handled in the front end. The front end is graphics-intensive.

The Excel software provides the graphical elements without need for additional programming. Categories of input parameters are divided into separate tabbed windows. Pop-up comments describe each parameter. An error-checking software component evaluates combinations of parameters and alerts the user if an error results. Case files can be created from inputs, making it possible to build cases from previous ones. Simulation output is plotted in 16 charts displayed on a separate worksheet, enabling plotting of multiple DSS cases with flight-test data. Variables assigned to each plot can be changed. Selected input parameters can be edited from the plot sheet for quick sensitivity studies.

*This program was written by Peter Cuthbert of Johnson Space Center. Further information is contained in a TSP (see page 1).* 
*MSC-24014-1*

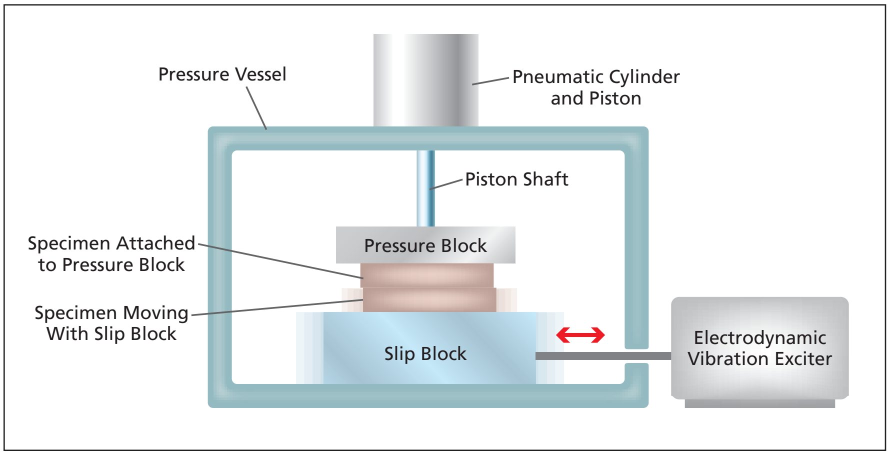
# Multimodal Friction Ignition Tester

## Responses of material specimens to vibrational friction in pressurized oxygen are recorded.

*Marshall Space Flight Center, Alabama*

The multimodal friction ignition tester (MFIT) is a testbed for experiments on the thermal and mechanical effects of friction on material specimens in pressurized, oxygen-rich atmospheres. In simplest terms, a test involves recording sensory data while rubbing two specimens against each other at a controlled normal force, with either a random stroke or a sinusoidal stroke having controlled amplitude and frequency. The term "multimodal" in the full name of the apparatus refers to a capability for imposing any combination of widely ranging values of the atmospheric pressure, atmospheric oxygen content, stroke length, stroke frequency, and normal force. The MFIT was designed especially for studying the tendency toward heating and combustion of nonmetallic composite materials and the fretting of metals subjected to dynamic (vibrational) friction forces in the presence of liquid oxygen or pressurized gaseous oxygen — test conditions approximating conditions expected to be encountered in proposed composite-material oxygen tanks aboard aircraft and spacecraft in flight.

The MFIT includes a stainless-steel pressure vessel capable of retaining the required test atmosphere. Mounted atop the vessel is a pneumatic cylinder containing a piston for exerting the specified normal force between the two specimens (see figure). Through a shaft seal, the piston shaft extends downward into the vessel. One of the specimens is mounted on a block, denoted the pres-




The **Pressure Vessel and Mechanisms** of the MFIT are depicted here in a simplified, partly schematic form emphasizing the basic principle of operation.