



## Insulation-Testing Cryostat With Lifting Mechanism

Cryogenic-insulation specimens can be tested reliably under typical conditions of use.

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The figure depicts selected aspects of an apparatus for testing thermal-insulation materials for cryogenic systems at temperatures and under vacuum or atmospheric conditions representative of those encountered in use. This apparatus, called “Cryostat-100,” is based on the established cryogen-boil-off calorimeter method, according to which the amount of heat that passes through an insulation specimen to a cryogenic fluid in a container, and thus the effective thermal conductance of the specimen, is taken to be proportional to the amount of the cryogenic fluid that boils off from the container.

The design of Cryostat-100 is based partly on, and incorporates improvements over, the design of a similar prior apparatus called “Cryostat-1” described in “Improved Methods of Testing Cryogenic Insulation Materials” (KSC-12107 & KSC-12108), *NASA Tech Briefs*, Vol. 24, No. 12 (December 2000), page 46. The design of Cryostat-100 also incorporates the best features of two other similar prior apparatuses called “Cryostat-2” (also described in the cited prior article) and “Cryostat-4.” Notable among the improvements in Cryostat-100 is the addition of a lifting mechanism that enables safe, rapid, reliable insertion and removal of insulation specimens and facilitates maintenance operations that involve lifting.

As in Cryostat-1, the cold mass is a vertical stainless-steel cylindrical vessel subdivided into a larger measurement vessel with smaller thermal-guard vessels at both ends. During operation, all three vessels are kept filled with liquid nitrogen near saturation at ambient pressure (temperature  $\approx 77.4$  K). The cold mass of Cryostat-100 has a length of 1 m and diameter of 168 mm. Each specimen has a corresponding nominal length and inner diameter and a nominal thickness of 25.4 mm. Specimens that are shorter and have thicknesses between 0 and 50 mm are also acceptable. Bulk-fill, foam, clam-shell, multilayer insulation, and layered materials can be tested over a very wide range of thermal transmission: apparent thermal conductivity from 0.01

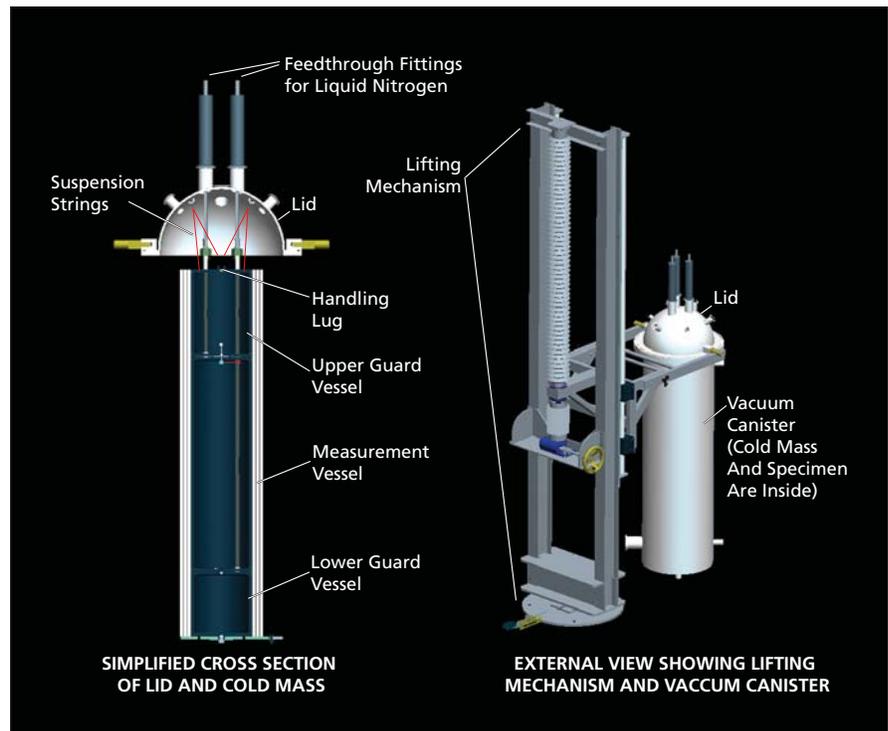
to 60 mW/m-K and heat flux from 0.1 to 500 W/m<sup>2</sup>.

A test in Cryostat-100 can be conducted at any desired gas pressure between ambient atmospheric pressure at one extreme and a vacuum with residual pressure  $<10^{-5}$  torr ( $<1.33 \times 10^{-3}$  Pa) at the other extreme. The residual gas (and purge gas) is typically nitrogen, but can be any suitable purge gas (e.g., helium, argon, or carbon dioxide). Usually, the temperature on the warm boundary of the insulation specimen is maintained near the ambient value (approximately 293 K), while the boiling of liquid nitrogen at atmospheric pressure in the cold mass maintains the temperature on the cold boundary of the specimen at approximately 77 K.

Much less ancillary equipment is needed for proper operation of Cryostat-100 than is needed for the prior apparatus: Unlike Cryostat-1, Cryostat-100 is not connected to a storage tank, phase separator, or subcooler. Cryostat-100 has

a top-loading configuration that makes it possible to perform convenient assembly, disassembly, insertion and removal of specimens, and connection and disconnection of instrumentation. The degree of thermal stability of Cryostat-100 is much improved because of the incorporation of internal vapor plates, a single-tube system for filling and venting, bellows feedthroughs, string suspension of the cold mass within the vacuum canister, and heavy-wall stainless-steel construction. Other features that contribute to reliability and efficiency in all phases of test procedures include guide rings, handling tools, and material installation fixtures.

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Cryostat-100 incorporates improvements over similar prior apparatuses that make it possible to perform test and maintenance operations faster and more easily and to better ensure the reliability of test data.