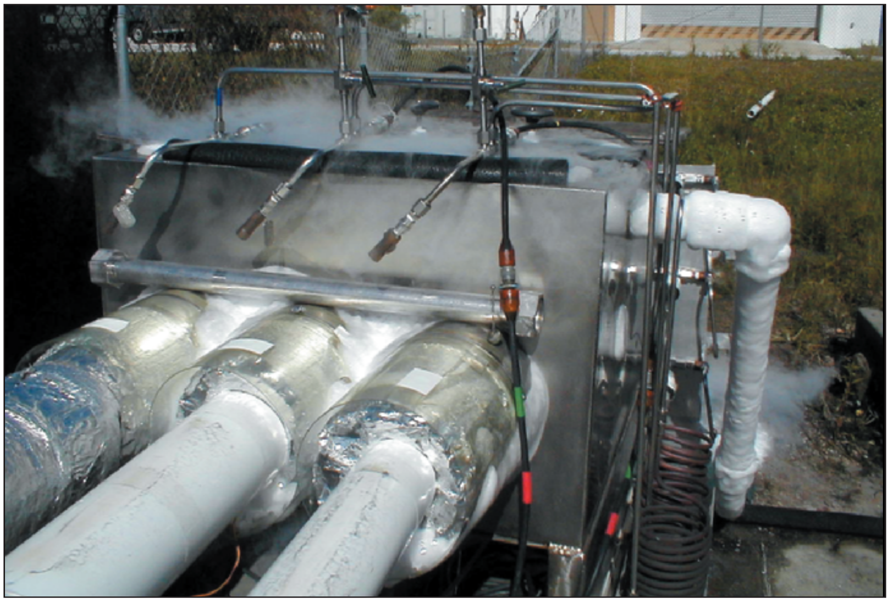
and pipe(s) are positioned so that the pipe(s) slope upward from the upstream to the downstream end at an angle of at least 2°. The upward slope allows vapor bubbles to accumulate at the downstream end.

The thermal guard boxes keep the ends of the pipes at the lower interior temperature to prevent spurious lengthwise leakage of heat into the pipes. It is important to prevent this spurious heat leakage because, if it were allowed to occur, it could contribute a large error in the measured heat-leak power. The upstream thermal guard box includes a heat exchanger through which liquid flowing into the pipe(s) is subcooled to the saturation temperature corresponding to the ambient pressure. Conversely, this heat exchanger can also be used to warm the flowing liquid to a desired fixed temperature.



Thermal Guard Boxes at the ends of a pipe under test are used to make the fluid connections to the pipe. In addition, a temperature control device imposes a specified temperature on the outer surface of the pipe insulation.

The apparatus includes a temperature control device that is placed around each pipe under test. Each device is operated under thermostatic control to maintain the outer surface of the pipe insulation at the specified test temperature. All measurements are recorded on a portable data-acquisition system.

This work was done by James E. Fesmire of **Kennedy Space Center** *and Stanislaw D. Augustynowicz and Zoltan F. Nagy of Dynacs, Inc. Further information is contained in a TSP (see page 1).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Technology Programs and Commercialization Office, Kennedy Space Center, (321) 867-8130. Refer to KSC-12205.

Electrical-Impedance-Based Ice-Thickness Gauges

Compact, inexpensive gauges provide early warnings of accretion of ice.

Langley Research Center, Hampton, Virginia

Langley Research Center has developed electrical-impedance-based ice-thickness gauges and is seeking partners and collaborators to commercialize them. When used as parts of active monitoring and diagnostic systems, these gauges make it possible to begin deicing or to take other protective measures before ice accretes to dangerous levels. These gauges are inexpensive, small, and simple to produce. They can be adapted to use on a variety of stationary and moving structures that are subject to accumulation of ice. Examples of such structures include aircraft, cars, trucks, ships, buildings, towers, power lines (see figure), power-generating equipment, water pipes, freezer compartments, and cooling coils.

A gauge of this type includes a temperature sensor and two or more pairs of electrically insulated conductors embedded in a surface on which ice could accumulate. The electrical impedances of the pairs of conductors vary with the thickness of any ice that may be present. Somewhat more specifically, when the pairs of conductors are spaced appropriately, the ratio between their impedances is indicative of the thickness of the ice. Therefore, the gauge includes embedded electronic circuits that measure the electrical impedances, plus circuits that process the combination of temperature and impedance measurements to determine whether ice is present and, if so, how thick it is. Of course, in the processing of the impedance measurements, the temperature measurements help the circuitry to distinguish between liquid water and ice.

Ice Accumulating on Power Lines poses a hazard. Gauges like those described in the text can provide early warnings of the buildup of ice.

The basic design of a gauge of this type can be adapted to local conditions. For example, if there is a need to monitor ice over a wide range of thickness, then the gauge can include more than two sets of conductors having various spacings.

This work was done by Leonard Weinstein of **Langley Research Center**. *Further information is contained in a TSP (see page 1).*
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