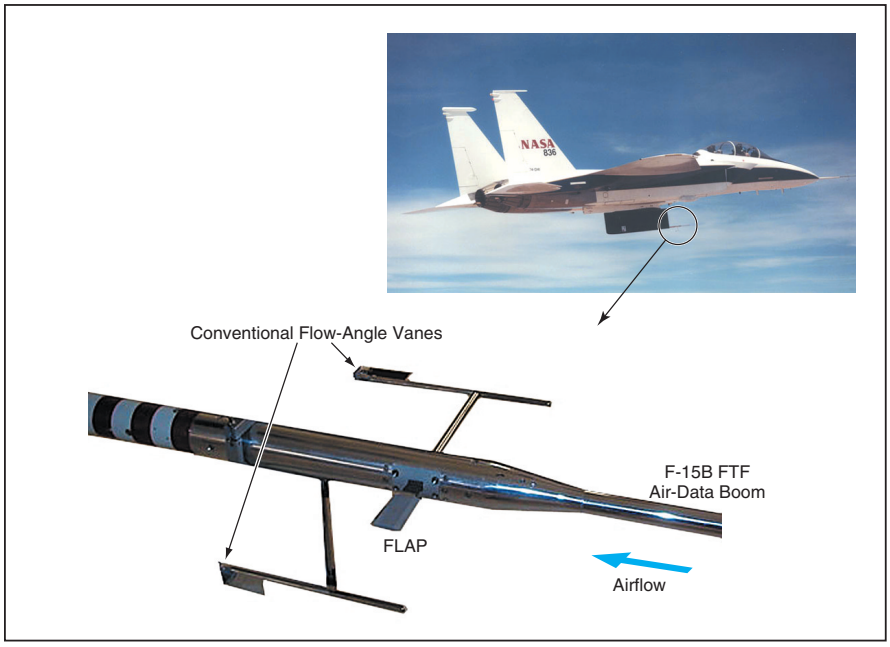

Figure 2. The **Air-Data Boom of the F-15B FTF** was used to carry the FLAP in a flight test.

F-15B fuselage (see Figure 2). Measurement data were collected as the FLAP was flown on the F-15B at subsonic and supersonic speeds up to mach 1.7 and altitudes up to 45,000 ft (≈13.7 km). FLAP data were also collected under high-angle-of-attack and high-vertical-acceleration flight conditions. The flight data analyzed to date have verified the feasibility of the FLAP concept.

In a second-generation FLAP now under development, the electrical-resistance-strain-gauge force-measurement system of the prototype FLAP is replaced with a fiber-optic-strain-gauge force-measurement system. This FLAP will also be flown on the NASA Dryden F-15B airplane.

This work was done by Stephen Corda and M. Jake Vachon of **Dryden Flight Research Center**. *Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Dryden Flight Research Center, Commercial Technology Office, (661) 276-3689. Refer to DRC-01-09.*

Detecting Conductive Liquid Leaking From Nonconductive Pipe

A capacitive detector is scanned over the ground above the pipe.

John F. Kennedy Space Center, Florida

A method that can be implemented with relatively simple electronic circuitry provides a capability for detecting leakage of an electrically conductive liquid from an electrically nonconductive underground pipe. Alternatively or in addition, the method can be applied to locate the pipe, whether or not there is a leak. Although the method is subject to limitations (some of which are described below), it is still attractive as an additional option for detecting leaks and locating pipes without need for extensive digging.

The method is based on capacitive coupling of an alternating electrical signal from the liquid to a portable electronic unit that resembles a metal detector. A signal voltage is applied to the liquid at some convenient point along the pipe: for example, the signal could be coupled into the liquid via an aboveground metal pipe fitting, the interior surface of which is in contact with the liquid. The signal is conducted through the liquid in the pipe; in the case of diffusive leak of liquid into the surrounding ground, the signal is conducted through the leak, into the portion of the adjacent ground that has become soaked with the liquid. (A drip leak cannot be detected by this method because there is no conductive path between the liquid inside and the liquid outside the pipe.)

The portable unit includes an electrically conductive plate connected to the input terminal of an amplifier. When the plate is brought near the pipe or the leaked liquid, a small portion of the signal power is coupled capacitively from the liquid to the plate. The user scans the plate near the ground surface to find the locus of maximum signal strength. The leak can be identified as a relatively wide area, contiguous with the location of the pipe, over which the signal is detectable.

In order for this method to work, the liquid must be sufficiently conductive, and must be significantly more conductive than the ground is. Thus, for example, the method does not work for pure water, which is nonconductive, and does not work where the ground has been soaked by a source other than a leak (e.g., heavy rain). It should be possible to apply this method to, for example, common polyvinyl chloride (PVC) pipes that contain impure water (e.g., swimming-pool water) leaking into fairly dry ground.

The resistance of a typical column of water in a PVC pipe is of the order of megohms. The combination of this order of magnitude of resistance with the order of magnitude of capacitance in a typical practical case dictates the use of a signal frequency or frequencies no higher than the low kilohertz range. Using the audibility of signals in the frequency range to make a virtue out of necessity, one could feed the detector-amplifier output to a set of earphones so that the user could keep visual attention focused on scanning the plate of the portable unit while listening for the signal.

This work was done by Robert C. Youngquist of **Kennedy Space Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Technology Programs and Commercialization Office, Kennedy Space Center, (321) 867-8130. Refer to KSC-12255.