

array performance was analyzed by the full wave method of moments solution to the pertinent integral equations. Monte Carlo simulations were also carried out to account for amplitude and phase errors introduced for the aperture distribution due to modeling errors as well as manufacturing tolerances. If the design margins for the average sidelobe level and the average return loss were not adequate, array architecture, lattice spacing, aperture distribution, and waveguide dimensions were varied in subsequent iterations.

Once the design margins were found to be adequate, the iteration was stopped and a good design was achieved. A symmetric array architecture was found to meet the design specification with adequate margin.

The specifications were near  $-40$  dB for angular regions beyond 30 degrees from broadside. Separable Taylor distribution with  $n_{bar}=4$  and  $-35$  dB sidelobe specification was chosen for each principal plane. A non-separable distribution obtained by the genetic algorithm was found to have similar characteristics.

The element spacing was obtained to provide the required beamwidth and close to a null in the E-plane end-fire direction. Because of the alternating slot offsets, grating lobes called butterfly lobes are produced in non-principal planes close to the H-plane. An attempt to reduce the influence of such grating lobes resulted in a symmetric design.

*This work was done by Sembiam Rengaranjan, Mark S. Zawadzki, and Richard E. Hodges of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-48481*

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## Motion-Corrected 3D Sonic Anemometer for Tethersondes and Other Moving Platforms

*Goddard Space Flight Center, Greenbelt, Maryland*

To date, it has not been possible to apply 3D sonic anemometers on tether-sondes or similar atmospheric research platforms due to the motion of the supporting platform. A tether-sonde module including both a 3D sonic anemometer and associated motion correction sensors has been developed, enabling motion-corrected 3D winds to be measured from a moving platform such as a tether-sonde.

Blimps and other similar lifting systems are used to support tether-sondes — meteorological devices that fly on the tether of a blimp or similar platform. To date, tether-sondes have been limited to making basic meteorological measurements (pressure, temperature, humidity, and wind speed and direction). The motion of the tether-sonde has precluded

the addition of 3D sonic anemometers, which can be used for high-speed flux measurements, thereby limiting what has been achieved to date with tether-sondes. The tether-sonde modules fly on a tether that can be constantly moving and swaying. This would introduce enormous error into the output of an uncorrected 3D sonic anemometer. The motion correction that is required must be implemented in a low-weight, low-cost manner to be suitable for this application. Until now, flux measurements using 3D sonic anemometers could only be made if the 3D sonic anemometer was located on a rigid, fixed platform such as a tower. This limited the areas in which they could be set up and used.

The purpose of the innovation was to enable precise 3D wind and flux meas-

urements to be made using tether-sondes. In brief, a 3D accelerometer and a 3D gyroscope were added to a tether-sonde module along with a 3D sonic anemometer. This combination allowed for the necessary package motions to be measured, which were then mathematically combined with the measured winds to yield motion-corrected 3D winds.

At the time of this reporting, no tether-sonde has been able to make any wind measurement other than a basic wind speed and direction measurement. The addition of a 3D sonic anemometer is unique, as is the addition of the motion-correction sensors.

*This work was done by John Bognar of Anasphere, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16310-1*

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## Water Treatment Systems for Long Spaceflights

**These methods enable recycling of urine to provide drinking water on long spaceflights.**

*Ames Research Center, Moffett Field, California*

Space exploration will require new life support systems to support the crew on journeys lasting from a few days to several weeks, or longer. These systems should also be designed to reduce the mass required to keep humans alive in space. Water accounts for about 80 percent of the daily mass intake required to keep a person alive. As a result, recycling water offers a high return on investment for space life support. Water recycling can also increase mission safety by pro-

viding an emergency supply of drinking water, where another supply is exhausted or contaminated.

These technologies also increase safety by providing a lightweight backup to stored supplies, and they allow astronauts to meet daily drinking water requirements by recycling the water contained in their own urine. They also convert urine into concentrated brine that is biologically stable and non-threatening, and can be safely stored

onboard. This approach eliminates the need to have a dedicated vent to dump urine overboard.

These needs are met by a system that provides a contaminant treatment pouch, referred to as a “urine cell” or “contaminant cell,” that converts urine or another liquid containing contaminants into a fortified drink, engineered to meet human hydration, electrolyte, and caloric requirements, using a variant of forward osmosis (FO) to draw