Short circuit severed satellite tether

When an electrified tether connecting a small satellite and the space shuttle Columbia broke in February, it left behind a mystery. Now, officials say they have a good idea what happened.

A jagged flaw in the tether's copper strands or an errant metal flake pierced its insulating layer, a NASA investigating board reported in Washington, D.C., last week. When a spark leaped from the unprotected cable to the shuttle's hull, the surge in electricity burned through the tether's layers of fiber, copper, and insulating plastic. In 9 seconds, investigators said, the tether broke.

Tests done later, on Earth, showed that any gap in the insulation leads to the same result. The report notes that sections of the tether's copper conductor "were nicked up to one-third of their diameter" during manufacturing. Also, sharp bits of aluminum, copper, iron, nickel, silver, and titanium were found embedded in the tether's jacket or loose in its reel mechanism.

A nick in the copper or a sharp metal flake probably sliced through the insulation as the tether was wound onto its spool, the report concludes. Exactly what happened will never be known because the evidence melted away.

"The threat to the insulation was just not appreciated prior to flight," said Kenneth J. Szalai, director of NASA's Dryden Flight Research Center in Edwards, Calif., and head of the investigating board.

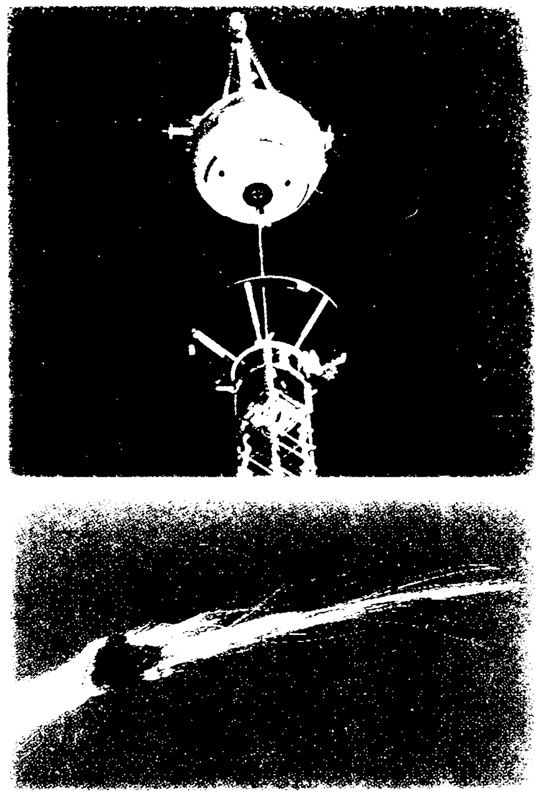
The same Tethered Satellite System flew aboard a shuttle in 1992, but the tether snagged like a tangled fishing line after unreeling less than 300 meters. This year, it snapped while passing through a series of pulleys in Columbia's cargo bay—just 1 kilometer short of the planned 20.7 km. Nobie H. Stone, NASA's mission scientist for the tether test, noted that the tether was almost 10 years old.

While the report declines to place blame for the failure, tether specialist Brian E. Gilchrist of the University of Michigan at Ann Arbor says more rigorous preflight testing might have prevented it. A "spark gap test" that detects holes in the insulation after manufacture could have been repeated before the flight, he noted.

Data collected before the tether snapped nevertheless proved that an orbiting satellite system can reap electric energy from Earth's magnetic field, says project scientist Carlo Bonifazi of the Italian Space Agency in Rome. The system generated electric current as it swept through the field at 8 km per second. The same principle governs a spinning dynamo in an Earth-bound power plant.

The electricity comes at a cost, however. As the satellite system gathers electrons, it loses a small amount of momentum and its orbit decays slightly. If scientists reversed the current, the system would become an "electrodynamic motor" that could push a spacecraft to a higher orbit, says Adam T. Drobot of Science Applications International Corp. in McLean, Va.

NASA



Above, the Tethered Satellite System at its Feb. 25 deployment. Below, the broken end of the 2.5-millimeter-thick tether shows charring from the electric arc that caused the break.

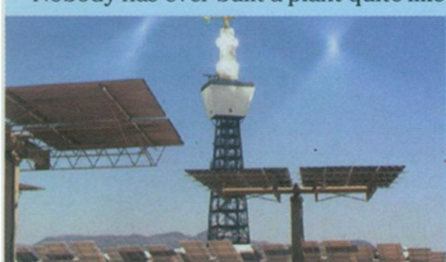
A pleasantly surprised Bonifazi said the data show that the electrical conversion process "is very efficient." The experiment recorded a peak current of 1 amp, he added, far surpassing preflight estimates. —*E. Skindrud*

Catching the sun to generate electricity

Sprawled across a flat, sandy stretch of the Mojave Desert near Daggett, Calif., a new solar power plant glitters in the harsh, unrelenting sunlight. The top of its tall, central tower glows fiercely in the intense light reflected by a vast, encircling field of sun-tracking mirrors.

Known as Solar Two, this experimental power plant uses focused sunlight to heat a mixture of molten sodium and potassium nitrates. The hot liquid, in turn, heats up water to make steam that runs an electricity-generating turbine. "Nobody has ever built a plant quite like this before," says chemical engineer Michael R. Prairie, who heads the Solar Two project team at Sandia National Laboratories in Albuquerque.

DOE



Large, adjustable mirrors direct sunlight onto the top of Solar Two's 300-foot central tower.

Last week, Energy Secretary Hazel R. O'Leary joined other officials to activate the plant, which is scheduled to operate until 1998 as a demonstration project to determine whether solar energy can be economically and efficiently stored to deliver electricity on demand. A consortium of electric utilities, high-technology companies, and the Department of Energy built the facility at a cost of $39 million.

Solar Two is the successor of Solar One, which operated from 1982 to 1986 at the same site. It generated electricity by using sunlight to produce steam directly. The new plant adds the capability of storing the sun's energy until needed.

At Solar Two, 1,926 steerable mirrors bounce sunlight onto a receiver at the top of a 300-foot tower. The receiver consists of pipes coated with a special energy-absorbing paint. As the 3 million pounds of nitrates flow through the pipes, the liquid gets heated to 1,050°F before being drained into huge insulated tanks. Thus, it's possible to collect and store solar energy during daylight hours and then tap this heat later that day to produce steam to run a turbine.

DOE

Solar Two's segmented mirrors are mounted on frames that track the sun throughout the day, continuously reflecting light onto the central receiver.

Solar Two can generate 10 megawatts of electricity, enough to power 10,000 homes. For Southern California Edison and other utilities, the new facility represents an alternative method of meeting needs when the demand for electricity is high—for example, during heavy air conditioner use on hot summer afternoons. —*I. Peterson*