Satellite salvage: High-tech handwork

Astronauts Dale Gardner (left) and Joseph Allen (right, standing at the end of the shuttle's remote-control arm) team up to salvage the Westar VI satellite.

In April, space shuttle astronauts plucked the Solar Maximum Mission satellite from its orbit, installed a new attitude-control system (ACS) in it and replaced an electronic box in one of its instruments (SN: 4/21/84, p. 245). Never mind that the satellite was designed for easy pickup (that part didn't go as planned anyway), or that the ACS was merely a plug-in module (the instrument box was not). The mission was still the first attempt to service one of the hundreds of man-made satellites that circle the earth—and almost none of the rest are the kind built to make it easy.

Last week, another shuttle crew (and another shuttle — Discovery instead of Challenger) took on two of the hard kind, and advanced the art of working in space a significant step further.

In-orbit repairs were not the idea. Western Union's Westar VI and Indonesia's Palapa B2 communications satellites were suffering primarily from having been placed in uselessly low orbits when their own built-in rocket motors malfunctioned following deployment from Challenger in February (SN: 2/18/84, p. 100). After paying out $180 million in insurance to the satellites' owners, the insurance underwriters paid the National Aeronautics and Space Administration $5.5 million (plus another $5 million to the satellites' builder, Hughes Aircraft Co.) to pick up the misplaced devices in hopes that they could be returned to earth, refurbished, resold and relaunched.

Before any such salvage could be conducted, Discovery's cargo bay first had to be emptied, which meant deploying two other communications satellites — Canada's Anik D2 and the Defense Department-leased Leasat 1 (Syncom IV-1) — that had formerly been the mission's primary items of business. Neither deployment required spacewalking assistance, and both went as planned, sending the satellites toward their proper orbits where they began to undergo checkout by their owners. In addition, Anik D2 was the third satellite in a row to use successfully an attached upper-stage rocket motor called a Payload Assist Module (PAM), following earlier PAM failures that had misorbited the other two satellites now about to become the focus of attention.

With veteran shuttle astronauts Joseph P. Allen and Dale A. Gardner set for the actual salvage operations, Discovery was maneuvered to within 35 feet of Palapa B2. Jetting across in the same backpacks that worked so well during the rescue of "Solar Max," they readily snagged Palapa by inserting an expanding-tipped "stinger" into the nozzle of its PAM. The stinger then became the handle by which shuttle-based astronaut Anna L. Fisher grasped the satellite, using the shuttle's remote-control manipulator arm, and pulled it back into the cargo bay. Here the spacewalkers were supposed to attach a bracket that would help with maneuvering Palapa into position for a firm mounting in the hold, but the unanticipated protrusion of a piece of the satellite itself meant that the bracket could not be used. With a strikingly brief amount of space-to-ground consultation, the crew switched to a backup plan in which they simply abandoned the whole bracket idea. Instead, Allen placed his feet in a set of restraints at the end of the remote arm and merely held the satellite (minus its 1,200 pounds of weight but still with all its inertia) in his gloved hands, while Gardner clamped it down.

Two days later, they did not even bother to try the bracket business with Westar VI. Gardner plugged in a stinger, after which Allen simply stood on the arm and hand-towed the satellite all the way back to the shuttle, where Gardner made it fast.

"The psychological boost to the insurance industry will be very considerable," says Stephen Merrett, head of the organization that had arranged the heavy underwriting in the first place. Expectations of skyrocketing insurance premiums had reverberated around the industry following the two satellites' original misdeployment, and the effect of the salvage remains unclear. But Merrett's group has already heard from potential buyers interested in the refurbished versions; the sales, he says, are expected "very shortly."

Also important to future work in space may be Allen's demonstration of moving large masses by hand. "None of us had seriously considered it," says one NASA official, "until we saw 'Little Joe' [who stands only 5′6″] out there holding those satellites." —*J. Eberhart*

Conducting a new polymer into batteries

A solid-state battery that can store a large amount of energy for a given weight and operates at room temperature may be one step closer with the development of a new conducting polymer. Eventually, such batteries, in which the electrolyte is a thin polymer film, may provide the concentrated power necessary for electric vehicles.

The new polymer, a derivative of polyphosphazene known as MEEP, is the product of a collaboration between inorganic chemists at Northwestern University in Evanston, Ill., and polymer chemists at Pennsylvania State University in University Park. Their report appears in the Oct. 31 Journal of the American Chemical Society.

Each molecule of the starting material, poly(dichlorophosphazene), consists of a long chain of alternating phosphorus and nitrogen atoms with two chlorine atoms attached to each phosphorus atom. Chemically replacing each chlorine atom by a polyether chain produces MEEP. The formation of MEEP-salt complexes with the introduction of various ionic compounds, such as lithium or silver salts, turns the polymer into an electrical conductor.

A typical polymer-electrolyte battery would consist of a lithium anode (positive electrode) coated with a thin film of a MEEP-salt complex, which allows the passage of lithium ions but not electrons toward the negative electrode. "The beauty of the polymer electrolyte is that it's pliant," says Northwestern's Duward F. Shriver. The polymer sticks closely to the electrodes and readily adapts to their expansion and contraction while they are charging or discharging. Furthermore, the natural motion of the polymer chains helps lithium ions get through the material.

Other polymer electrolytes, like those based on poly(ethylene oxide) complexes, have been developed, but these are suitable only for batteries that run at temperatures above 100°C. The new polyphosphazene electrolyte is a good candidate for a room-temperature, thin-film battery, the researchers report. Says Shriver, "This way, you don't have to heat up your battery before you start your car."

However, if the development history of liquid-electrolyte, high-energy-density batteries for electric vehicles is any guide, says Shriver, tremendous technical problems remain before a practical battery can be produced. —*I. Peterson*