NASA Racing the Sun to Save a Satellite

If the shuttle cannot reach the LDEF satellite by January, the sun's increasing activity will drag it down to destruction

THE NATIONAL AERONAUTICS and Space Administration is racing to pluck one of its satellites out of the sky before the $15-million piece of hardware turns into a fireball. If NASA is able to retrieve its Long-Duration Exposure Facility (LDEF) from orbit this December, researchers and engineers will have a treasure trove of information on how materials degrade in space. If it doesn't, 10 years of planning and 56 experiments will be obliterated in a spectacular plunge from orbit and a rain of charred debris. The race to save LDEF will be close, for it is expected to reenter the atmosphere in January.

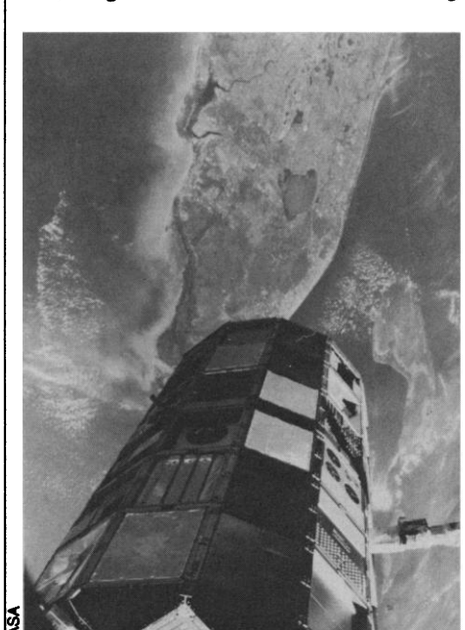
It is not gravity alone that is bringing LDEF down; it is Earth's atmosphere abetted by the sun's burgeoning sunspots and flares. This solar activity, now soaring toward record levels, has riveted the attention of everyone operating satellites in low Earth orbit (*Science,* 19 August 1988, p. 902). The outermost tendrils of Earth's atmosphere slowly drag low-flying satellites earthward—to their ultimate destruction—but the sun's present hyperactivity is expanding Earth's upper atmosphere through warming, thereby markedly increasing the drag felt by satellites.

Three U.S. satellites are particularly prone to solar drag. In fact, one is already a goner. Launched in 1980 and repaired by a shuttle crew in 1984, the Solar Maximum Mission satellite "is expected to begin tumbling by about August and reenter a few months later," says George Withbroe of the Harvard-Smithsonian Center for Astrophysics in Cambridge. Withbroe cochairs a committee of experts advising NASA on current forecasts of solar activity. There will be considerable irony in Solar Max's premature passing: it is the leading satellite for the study of the sun and will be brought down before any replacement arrives by the very object it has been studying.

A second vulnerable satellite was the Hubble Space Telescope—or rather, it would have been had it been launched when and how originally planned. The launch has been extensively delayed, which fortuitously avoided part of the growing peak of solar activity. NASA also found ways to squeeze a little more power, and therefore a crucial few more kilometers of altitude, out of the shuttle. Thus, the telescope "should be okay," says Withbroe. If it had gone up on time, NASA might soon have been looking around for another shuttle mission to boost it into a higher orbit.

That leaves LDEF as the sole U.S. satellite whose fate hangs in the balance. The cylindrical 16-ton satellite, the size of a small bus, was launched by the shuttle in 1984 into a 475-kilometer orbit. It had been covered with test materials that were to be exposed to the harsh sunlight, radiation, and micrometeorites at low orbit. The shuttle was to have retrieved the satellite for ground-based study after 1 year in orbit, but the Challenger accident delayed the return trip to set up the present cliff-hanger.

The edge of that cliff is getting closer day by day. By early this year, LDEF had only fallen to about 445 kilometers from its 475-kilometer start, but it is now at 420 kilometers and will be down to about 300 kilometers in December, according to Burt Lightner of the LDEF project office at the NASA Langley Research Center in Hampton, Virginia. That's still safe but nearing the point of no return, which would come in January, were the craft to be permitted to fall much below 200 kilometers. Then its end would come within days.



NASA

LDEF at its highpoint. *The materials testing satellite has been falling ever faster for 5 years.*

That's why NASA announced on 14 June that it would make its last second attempt to save the LDEF with the 18 December launch of Space Shuttle Columbia. If that target date should be missed, there may be about 30 days before the craft falls below 200 kilometers but, says Jerry Fitts of NASA headquarters in Washington, "there are still a few questions about retrieval as low as 240 kilometers." Still, he adds, "we're discussing the possibility of going as low as 185 kilometers." That would surely make the race a photo finish.

NASA may not even have realized it was going to be in such a race, however, if solar physicists had not issued warnings 2 years ago that the sun might be up to no good. In early 1987, several independent researchers inspecting the quiet sun at the minimum in its 11-year cycle of activity predicted that the next maximum would be far higher than average and possibly equal to the highest peak of activity on record, the one in 1958.

These predictions ran counter to conventional wisdom, for projections based on trends in solar behavior during the past 130 years tended to call for an average solar cycle. The high predictions are, however, now being borne out. "This cycle looks a lot like cycle 19, which was the biggest on record," says Withbroe. "Our best guess is that this cycle will be like it."

Specifically, the NASA committee is calling for a maximum smoothed sunspot number, a common gauge of solar activity, of 195 ± 40 to occur next February. The average maximum is about 110, and the previous record was 201. The National Oceanic and Atmospheric Administration's Space Environment Laboratory in Boulder is calling for a similar number of 203 ± 30 in March. Both predictions are based on how fast activity has been rising lately.

Even if NASA neatly plucks LDEF from the brink of destruction, the sun will still be dishing out plenty of abuse. A burst of activity last March, including a massive flare, created a geomagnetic storm that disrupted communications, knocked out power in Canada, and sent the northern lights as far south as the Gulf Coast. "That was a rare phenomenon," says Joseph Hirman of the Boulder center. "By some measures it was the third largest on record, but it's probably going to happen again. We expect another one this month or next, although we don't know how big it will be. If this cycle is anything like past ones, you'll have two to three more years before things die down."

■ RICHARD A. KERR