# Redesign of Ariane Is Under Way

*Failure of the European launcher last May could slow development of newer vehicles for putting satellites in orbit*

*Paris*

THE next flight of the European launcher Ariane has been delayed for at least 6 months to allow for a major redesign of the third-stage ignition system that failed during the rocket's last launch at the end of May. The failure has temporarily deprived the West of all its commercial satellite launching facilities as a result of U.S. space shuttle disaster and the subsequent failures of both the U.S. Delta and Titan rockets.

Frédéric d'Allest, chairman of Arianespace, the company responsible for the commercial operation of Ariane, said here recently that the report of a board of inquiry set up to investigate the launch failure had concluded that there was a "fundamental and generic problem" in the current system used to ignite the mixture of liquid oxygen and hydrogen in the third-stage engine.

However, he said that he hoped launches would be resumed "early next year." Arianespace currently plans to keep to the present order of flights—the next, which had been planned for this month, would have launched a European and an American communications satellite—and is confident that, if all goes well with the design and testing of the new ignition system, it will still be able to make its target of eight launches next year.

The failure of the 30 May launch has been embarrassing for Arianespace. Not merely was the company in the middle of signing up several customers who had previously been booked for the space shuttle, but the failure was the second in four launches (the earlier one occurred last September).

Furthermore, on both occasions the problem developed during the ignition procedures for the third, cryogenic stage, which places satellites in geostationary orbit. This procedure is initiated by an explosive charge that is set off in the combustion chamber in order to ignite the combination of hydrogen and oxygen, which have just been fed into it by a turbopump.

The precise timing of the explosion of the charge has always been recognized as highly critical. In last September's launch, some hydrogen leaked through the valve before the explosion took place, and although the amount involved was relatively small, it disturbed the conditions sufficiently in the combustion chamber to prevent ignition.

At the time, the company responsible for making the engine, the Société Européene de Propulsion (SEP), suggested that a new ignition system was needed. However, both Arianespace and the National Center for Space Studies (CNES)—which was responsible for developing Ariane on behalf of the European Space Agency (ESA)—decided that the problem could be resolved through various engineering modifications, since the ignition procedures had worked perfectly on the previous nine launches.

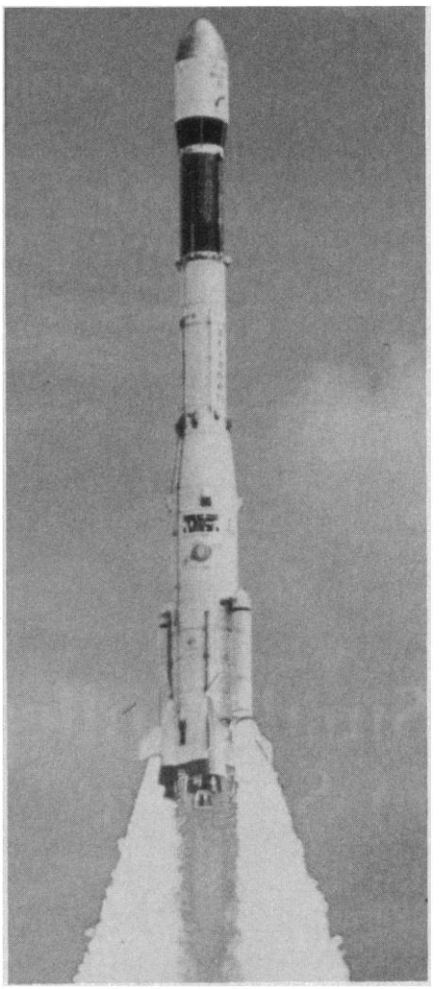
For the next two launches, including that of France's remote sensing satellite SPOT, the modifications seemed to work. On the third, however, luck ran out, and the rocket had to be destroyed after the last stage had once again failed to fire.

An investigation carried out after the failure by an international board of inquiry has now reached the conclusion that a first, partial ignition of the third-stage engine had occurred, but it proved insufficient to cause combustion. A second ignition took place 0.12 seconds later. However, by this time the pressure level in the combustion chamber was "abnormally high," resulting in a "high pressure peak" and the subsequent extinction of the engine.

"According to all production documents, the quality control files show no faults concerned with the manufacturing of the engine," says Reimar Lüst, the director general of ESA. "However, there is a high probability that the margins available for ignition were exceeded."

On the advice of the board of inquiry, SEP, the engine manufacturer, has now been asked by Arianespace to make a detailed study of the ignition conditions inside the engine to design a new, more powerful third-stage igniter and to carry out a thorough schedule of firing tests in simulated flight with the new ignition system before the next launch of Ariane.

According to Lüst, the design and testing program will, at a provisional estimate, cost "several tens of millions of dollars." This sum will be shared between ESA, Arianespace, and SEP.



**Europe's Ariane** *space launcher now has failed twice.*

First tests of the new ignition system, on which work had already begun last November after the earlier launch failure, should take place in August. The board of inquiry is being kept together so that it can evaluate the results of these tests, and a decision will subsequently be made about when launches can be restarted. Even an 8 month delay will be the longest between two successive Ariane flights since 1982.

Demonstrating the reliability of the new ignition system is seen by Arianespace as critical if it is to maintain the commercial momentum, boosted by the space shuttle's problems, that has already allowed it to capture 50% of the market for commercial satellite launches, with total contracts signed so far worth more than $1.5 billion.

Since the same engines will be used on the more powerful version, Ariane IV, whose first flight was to have taken place later this

year, the technology is likely to be used "for at least the next 20 years," says d'Allest.

Still unknown is the impact that the effort required for the redesign of the ignition system will have on work that is already under way at SEP and elsewhere on the development of a much larger cryogenic engine, known as HM60. This is currently planned to be the main engine for the much larger single-stage Ariane V, which CNES hopes will be ready for launch by 1995 and will be man-rated, in order to carry the mini-shuttle Hermès.

The dangers that would be created by a similar malfunction in the HM60—recently renamed Vulcan—will be minimized by the fact that it will be ignited before the launcher leaves the ground. And Jean Sollier, the chairman of SEP, said last week that the new work on the HM7 will provide useful knowledge for the development of the Vulcan engine.

However, he admitted that work on the Vulcan motor at SEP "will obviously be disturbed," and in particular that the skilled manpower and technical facilities available were likely to be stretched. "When you take a number of technical resources and dedicate them entirely to one project, then these resources are obviously not available to do anything else," he said.

The problem with the Ariane engines has come at a particularly critical time for ESA, which is still locked in an internal debate over the major directions of its space technology programs up to the end of the century. In particular, the prospects are growing for a heated battle for European-level funding between the Ariane V/Hermès combination, and Britain's proposal for a horizontal takeoff launcher (HOTOL), whose engines would operate on very different principles (*Science*, 17 January, p. 209).

D'Allest of Arianespace is philosophical about the current problems with Ariane; "the technology in all these areas is such that we have to go slowly and envisage failures," he says, adding that "we are still signing launch contracts." D'Allest also denies the charge, made in an article in the *Los Angeles Times* last week, that the French government is taking seriously the hypothesis that Ariane might have been sabotaged. "All the tests which have been carried out so far have given no positive indication along these lines, and we see no reason to support such a hypothesis." ■ **DAVID DICKSON**

# Small Colleges Strong in Science

## *But there is concern that the ability to produce talented students for science graduate schools may be diminished in the future*

A group of selective colleges that send more than their share of graduates into the sciences are worried about being able to do so in the future. At a recent conference on the future of science at liberal arts colleges, leaders of 50 private colleges and small universities met to discuss joint action to preserve their niche in science education.

Meeting at Oberlin College in Ohio, college presidents reviewed their recent science track records with satisfaction, noting that it puts them on an equal footing with the leading universities in turning out basic science majors. The colleges also rate well in the percentage of students completing doctoral degrees in science and going on to distinguished scientific careers. According to a background report* released at the meeting, a subgroup of fewer than a dozen of the colleges "stand fully on a par with leading research universities" in the quantity and quality of their science graduates.

The colleges' partisans agree that the main element in keeping them competitive is that they not only emphasize teaching but that their science faculties include practicing researchers. The report says that 60% of faculty at the 50 institutions averaged at least one article published in each of the past 5 years. It also notes that "students themselves are actively engaged in scientific research. Nearly 30% of all scientific articles produced at the colleges are jointly authored by undergraduate students and their faculty mentors."

The report notes that among its conclusions, "The most important is that over the next decade America's top liberal arts colleges must invest a total of one billion dollars above current commitments if they are to maintain and enhance their present strong position in basic science." The report was prepared by Oberlin provost Sam C. Carrier and director of institutional research David Davis-Van Atta.

Comparisons are made generally with selective universities with which the colleges traditionally compete for undergraduates and to which they send graduate students. The colleges continue to do well. Compared to highly selective private universities, for example, the colleges have had a higher percentage of freshman majors in science and succeeded better in keeping the percentage up. The figures for a group of highly selective universities were 26.4% in 1976 and 15% in 1985. Comparable figures for the colleges based on a sample of 19 of the 50 were 31.8% in 1976 and 29.2% in 1985. Both sets of institutions far exceed the national average, which last year was between 5 and 6%.

The demographic outlook in the next decade is daunting. Not only will the size of the college-age cohort reach a low point in the mid-1990's, but the percentage of entering freshmen interested in science has been declining—nationally it fell from 9.9 to 5.5% between 1975 and 1985. The number of Ph.D.'s awarded in the sciences fell by some 11% in the same years.

Postbaccalaureate, the colleges rate favorably both in percentages of science students going on to graduate school and on qualitative grounds. Among the ten institutions with the highest per capita production of winners of the prestigious National Science Foundation Fellowships from 1976 to 1983, five were liberal arts colleges.†

Faculty demographics look even more dismal to the small colleges. Like the universities, the colleges have a bulge of faculty recruited in the period of major expansion in the 1960's and early 1970's. When these faculty members retire and have to be replaced starting in the 1990's, the colleges

**Maintaining America's Scientific Productivity: The Necessity of the Liberal Arts Colleges*, Oberlin College, Ohio.

†The top ten institutions in order were Caltech, Swarthmore, Harvey Mudd, MIT, Harvard, Reed, Chicago, Yale, Pomona, and Bryn Mawr.