Tom Maniatis, *a founder of Genetics Institute, says the technology to clone TPA was "common knowledge."*

only comment that the company is trying to extend the half-life too. The company is expected to make a strong bid to produce an alternative TPA because it has retained all the rights to manufacture a modified molecule and is not obligated to license the new technology to Wellcome as it did with its first-generation TPA. (It will be interesting to see what approach Genetics Institute is taking, given that Kamen and Smith conducted research together for 8 years at the Imperial Cancer Research Fund and coauthored scientific papers while there.)

Technical know-how to grow mammalian cells in large volume and sufficient plant capacity are also crucial factors that will help determine which company prevails in the TPA contest. Growing massive quantities of animal cells is still more an art than a science because mammalian cells are finicky creatures. Analysts say that only Genentech and Wellcome currently have the combination of expertise and facilities to grow large quanities of mammalian cells. But Genetics Institute expects to have a substantial capacity to grow these cells in the future. This year, it signed a joint venture with Wellcome to build a mammalian cell culture production plant in Massachusetts. The plant, called WelGen, is expected to be on-line by 1989.

For now the TPA battle is mainly between Genentech and Wellcome. Kamen notes that the decision by the FDA advisory committee "gives competitors a time advantage. We gain whatever time Genentech loses. Before Genentech had a $2\frac{1}{2}$-year time lead. Now the gap could be narrowed by anywhere from 6 months to a year." ■

MARJORIE SUN

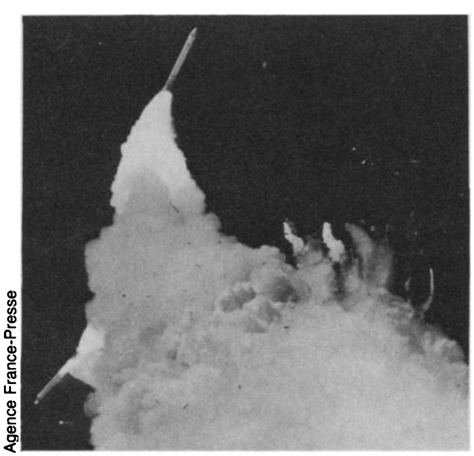
Research Council Critiques NASA's Booster Redesign

The National Aeronautics and Space Administration's (NASA's) recent decision to delay its first post-Challenger space shuttle flight from February to June 1988 has done little to ease the pressure on its solid rocket booster testing program, according to the latest report from an oversight panel convened by the National Research Council.

Indeed, as the agency moves toward full-scale testing of the redesigned boosters it is still operating in a success-oriented mode, writes panel chairman H. Guyford Stever in a 22 June letter to NASA administrator James C. Fletcher. Schedules continue to be based on the presumption that the new "baseline" design for the boosters, which is receiving the lion's share of attention from the engineers at NASA and at prime contractor Morton Thiokol, will work as planned—a situation that the panel has criticized before and still finds troubling.

Stever's letter is the fourth in a series of interim reports by the panel, which was established last year to provide an independent assessment of NASA's efforts to fix the faulty booster joints that burned through and destroyed the Challenger and its crew on 28 January 1986.

The panel did concede that the booster redesign team faces a tough management problem. NASA and Morton Thiokol have only so many test facilities to work with and only so many skilled engineers who understand the boosters; thus, the decision to concentrate resources on the baseline design is understandable. Nonetheless, say the panel members, that strategy is inherently risky, and could backfire if the baseline design proves inadequate in full-scale tests, which are slated to begin this summer. The inevitable result would be more expense and delay.



Agence France-Presse

28 January 1986. *Still firing, the solid rocket boosters go their separate ways as they emerge from the Challenger fireball. Flame can be seen emerging from the ruptured joint in the lower booster.*

The issue of risk is particularly acute right now because the booster redesign is still the most critical element in getting the shuttle ready to fly by June 1988. The decision to delay the first flight gave the redesign team little respite, since the delay is mainly intended to accommodate a full-scale test firing of the shuttle next spring while it is on the launchpad at Cape Canaveral. Yet that test will require using a real set of solid rocket boosters, which means that the first set of flight-ready boosters will have to be delivered by December. The only way that can happen, however, is if all three of the upcoming booster tests go perfectly.

Of the many specific concerns that Stever raises in his letter, perhaps the most urgent relates to the booster team's strategy of "testing with defects." The idea, which Stever and his colleagues endorse in principle, is to measure the margins of safety in the system by introducing deliberate flaws into the joints of the test boosters and seeing what happens. Indeed, since the very act of assembling the booster segments can introduce defects in the joint, and since certain of those defects cannot be detected afterward, this approach is essential.

However, Stever and his colleagues also point out that when using this approach it is critical to identify the "worst credible" flaw in each case, as opposed to the worst imaginable flaw. Otherwise, NASA could end up wasting enormous amounts of time and money protecting against more and more baroque failure modes, while still missing the most threatening of the boosters' real-life problems.

A case in point is the joint between the booster's exhaust nozzle and its main body, where the NASA-Thiokol team is planning to introduce a set of simultaneous failures in the O-rings and in the adhesives of the joint. This combination of flaws is so serious that, in the panel members' judgment, it will cause the joint to fail during the test and will force yet another delay while the connection is redesigned. And yet, the panelists say they are not convinced that the engineers have done enough analysis to prove that the flaw is credible. As the panel's executive director, Myron Newman points out, "We wonder how real this is. We can't say yet whether the test is too stringent, or not stringent enough. What we do say is that they have to do some work on the problem." ■

M. MITCHELL WALDROP