# Space shuttle takes to the air

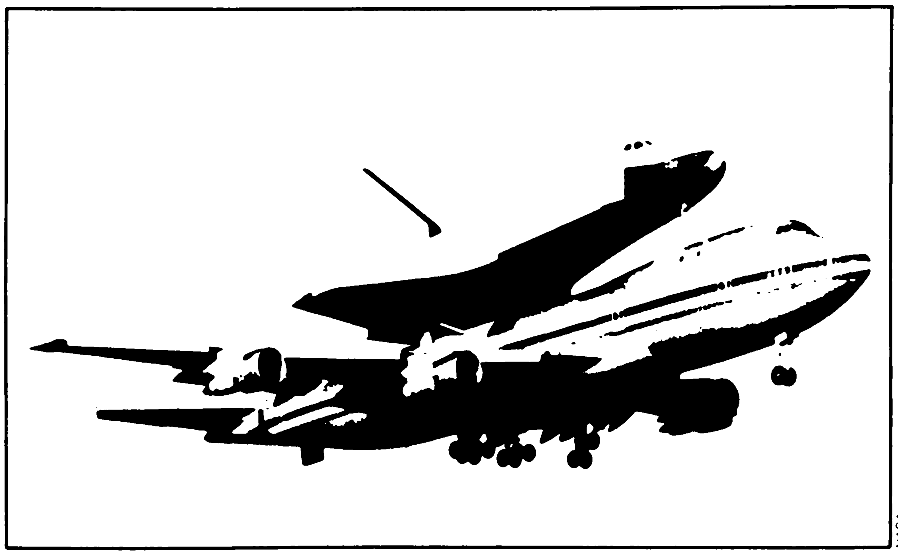
The space shuttle left the ground for the first time last week, only two days before the fifteenth anniversary of the first U.S. manned orbital spaceflight. Actually it had "left the ground" several days before, when it was mounted high atop the 747 jet that would carry it on its maiden test. And until the shuttle blasts off for orbit in 1979—going up as a rocket, coming down as a glider—the hefty 747 will be its vital link with flight.

The ungainly-looking couple got underway at 8:30 (PST) on the morning of Feb. 18. Together the two vehicles weighed in at a ponderous 584,000 pounds, 150,000 of which were contributed by the empty shuttle, carrying neither crew nor fuel. Yet this is less than a fully loaded 747 carries on an intercontinental hop. "Most of the flight," said the plane's command pilot, Fitzhugh L. Fulton of the NASA Dryden Flight Research Center in California where the test took place, "we couldn't even tell the shuttle was there." Quite a claim, considering that he was flying his superjet with what amounted to a DC-9 bolted to the roof.

The flight lasted about two and a half hours, reaching a maximum altitude of about 16,000 feet before ending in a picture-book (if not record-book) landing. A total of six such runs is scheduled (the second was this week) before the shuttle ever takes a crew aloft. They are needed to check out the stability and aerodynamics of the vehicle, as well as to verify the safety of the piggyback arrangement. The first astronauts to ride along, beginning in May, are scheduled to be Fred W. Haise Jr., as "commander" and Charles G. Fullerton as "pilot," alternating through a planned half dozen flights with Joe H. Engle and Richard H. Truly. Besides monitoring the craft's performance in person, their jobs will include refining crew operations procedures on board and helping to work out the optimum flight profile for the subsequent test series, when for the first time the shuttle will be turned loose on its own.

The shuttle gets only one chance at a safe homecoming. After leaving orbit with an initial push from its rocket engines, it will glide down on its stubby wings for a dead-stick landing. The rocket-powered ascent cannot really be tested until it happens; no suborbital flights are planned, since the craft will have to get all the way around the planet to get back to the six-mile landing strip being built for it on Cape Canaveral. Thus all of the "747-powered" tests are concerned with the final approach and touchdown.

The shuttle will make its first independent landing in July, beginning when a series of explosive bolts are fired to free the craft from its 747 carrier at an altitude of about 22,000 feet. At that point, for the first time, the shuttle will have to prove its mettle.



NASA

*To test its performance in the atmosphere, the space shuttle gets a lift from a 747.*

It's spectacular, it's futuristic, and it will have to take on most of the work from a wide variety of conventional "launch vehicles" for both the National Aeronautics and Space Administration and the U.S. Air Force. But for all its new and exotic ways, it will have to be routine. For in essence, the space shuttle is nothing more than a truck, designed to handle as many as 60 launches a year (using several shuttles working in rotation) without all the attendant difficulty that has made every past launch a major, one-of-a-kind endeavor.

Frank Curtis, program manager for the Boeing Co., builder of the 747, has the right idea. "There's nothing better than this," he said after last week's successful landing. "Nothing better than good old boring routine." The second flight was also an uneventful success. □

# Tracing toxic environmental chemicals

Despite great concern over toxic and carcinogenic chemicals in the environment, there is surprisingly little information on which substances are actually present or potentially dangerous. Chemists are starting to use sensitive research techniques for identifying and detecting industrial organic wastes in soil and water. Biologists, meanwhile, look for reliable tests to determine which compounds present health hazards. At a symposium last week at the Massachusetts Institute of Technology, speakers reported progress in detecting nanogram amounts of organic chemicals, as well as in experiments using human cell cultures to identify potential carcinogens.

Chemists have applied biomedical research techniques to the detection of organic compounds in industrial waste water. By using gas chromatographic mass spectroscopy (GC/MS), organic compounds present in concentrations as low as 50 parts per trillion can be detected easily, according to Ronald A. Hites of MIT's chemical engineering department.

At present, most industries make only gross measurements of the total organic compound in their waste water, but do not know which specific compounds are released into the environment. While most of an industrial plant's organic wastes may be degraded before going into a river, levels of individual compounds can remain high, and these undegraded compounds may be hazardous.

GC/MS provides a powerful tool for monitoring the environment near industrial plants. For instance, Hites and coworkers studied the water and sediments near a chemical plant and near a dye plant. The dye plant wastes were quickly diluted and did not accumulate in the area, whereas sediments near the chemical plant showed a previously undetected buildup of many organic compounds. With sensitive analytical techniques available, it should now become possible to regulate the release of specific compounds by industrial plants.

A basic reason for identifying environmental chemicals is to determine which ones may become health hazards. It is particularly important to identify potential carcinogens whose effects often do not appear for many years. During the past few years, a simple bacterial test for potential carcinogens has been widely used. This test depends on the fact that most known carcinogens are also mutagens and cause changes in the DNA of the bacterial cell. These DNA changes then cause enzyme alterations.

However, bacterial cells are not human cells and many biologists feel that more meaningful results could be obtained from testing potential carcinogens with human cells. William Thilly's group at MIT report they have recently successfully tested compounds for mutagenic activity in cultures of human cells. They used a strain of human lymphoblasts (derived from white blood cells) that contain 46 chromosomes, the normal number for human cells. The lymphoblast test is still in a developmental stage compared with the standardized bacterial assay, according to researcher Bruce Penman.

Penman compared some characteristics of the lymphoblast and bacterial tests. Primarily the researchers believe that information they obtained from the human cells will show more accurately what happens in the human body than does the bacterial test. The lymphoblast test is quantitative, so that different compounds can be compared for their ability to cause mutation, Penman noted. Researchers usually use the bacterial test only qualitatively. On the other hand, each test with human cells takes about a month, compared with the few days required for a bacterial test. However, animal tests can take years.

In the lymphoblast assay, researchers determine whether the suspected mutagen changes a particular enzyme into an inactive form. Under some culture conditions, only cells that do not have an active enzyme called hypoanthine-guanine phosphoribosyl-transferase (HGPRT) can survive. This enzyme normally reacts with the base guanine, but it can also react with compounds that resemble guanine such as 6-thioguanine. When HGPRT reacts with 6-thioguanine, the 6-thioguanine gets into the DNA and the cell dies. But if the enzyme has been mutated so it is inactive, the 6-thioguanine does not enter the DNA and the cell survives. The test determines whether HGPRT has been mutated to an inactive form by looking for cells that can survive when 6-thioguanine is introduced into the culture. □

# The long and short of gas supplies

Natural gas heats roughly half of American homes and fuels 40 percent of the country's industry, yet domestic production of this vital energy source has been allowed to drop nearly 12 percent over the last three years. Still worse, a decline in exploratory drilling has decreased proven reserves so that the United States is now burning gas at twice the rate new sources are being discovered.

A gas shortage has thus been inevitable for years and no one with a passing knowledge of the situation was terribly surprised when this winter's extreme cold suddenly precipitated a crisis. Where to place the blame and what to do in the future, however, are still subjects for much wrangling—though ultimately it has been inaction, resulting from previous argument, that has produced the present emergency.

As winter grew more bitter, gas was diverted at the state level from industry to homes and "essential human services." A national problem then developed in delivering the gas from well-off portions of the country to those hardest hit. Jimmy Carter's first signature as President brought into law an emergency gas bill giving the federal government authority to transfer gas supplies to deal with temporary shortages. Now, the first major legislative battle of the new administration has begun to develop over the President's proposals to stimulate the economy and help those thrown out of work by the gas shortage.

A long-term solution to the problem, however, can rest only on increased drilling, conservation and the search for alternatives to natural gas. That, in turn, focuses attention on the critical question of whether gas companies have been slowing production to drive up prices, or whether prices have been so low that nothing else could drive up production.

Since 1954, the Federal Power Commission has maintained very low ceiling prices on gas sold interstate. As a result, demand has soared while production and rate of drilling have plummeted. Finally, last year, the FPC allowed the so-called "wellhead" price of gas to triple—from 52 cents per thousand cubic feet (Mcf) to $1.42 per Mcf for new gas. But even that boost left the price of interstate gas substantially below the $2.25 that producers could get if they did not trade out of state, and thus avoid FPC control. (One thousand cubic feet of gas will heat the average home for about three days.)

But did the gas companies involved intentionally withhold supplies they had? A very quick survey of five gas fields, prepared for the Department of Interior, has convinced Secretary Cecil Andrus that the question is at least worth a full-scale investigation. The preliminary survey found that the fields contained 225 nonproducing reservoirs of gas but that only 19 reservoirs had been brought into production since 1974, despite companies' promises that many more of the reservoirs would be tapped. For producing reservoirs, the survey team found that an average of production rates for four of the fields was only 58 percent of the "maximum efficient rate." Finally, within individual fields, the survey report concluded that several producing wells had been shut down for no apparent reason.

In a press conference last week, Andrus cautioned that "today isn't a day to point a finger of blame." The preliminary survey, he said, was intended only to see if a wider investigation of the gas companies was needed. However, he did blame previous administrations for not watching production figures more closely. The Interior Department has had authority for more than a year to order companies to increase production rates, Andrus said, but nothing was done until this January.

Again, charges of chicanery, leveled against the gas companies, are nothing new. Conclusions from past confrontations are not clear:

• A 1974 FPC investigation of offshore fields showed that 4.71 trillion cubic feet (Tcf) of proven reserves and an additional 3.27 Tcf of probable reserves were underlying leases that had not yet been brought into production. (U.S. consumption is about 20 Tcf per year. Producing companies replied that 2.8 Tcf were committed to contract or were awaiting installation of pipelines, 1.1 Tcf were still being negotiated, and 0.8 Tcf were presently uneconomical for laying pipe.)

• Critics have charged that in offshore areas leased by the Department of Interior, 9 out of 10 leases are not producing. Gas producers reply that 9 out of 10 wildcat wells are dry holes and that the ratio of productive areas is about what would be expected.

• Estimates of reserves in certain offshore gas fields, made by the American Gas Association, have turned out 37.4 percent lower than those made by the U.S. Geological Survey. The association explains the difference by saying it uses stricter criteria—specifically, an actual production test—which USGS does not require.

• Many homeowners, whose gas bills have sometimes doubled with higher prices and a colder winter, became livid when some gas companies reported fourth-quarter "windfall" profit increases of more than 50 percent, compared with last year. The companies explain that such an increase is built into the present rate structures, and some offer rebates.

For the long-term, new sources for gas must be found, but development of them will also depend on the price people are willing to pay for this clean, convenient fuel. So-called "enhanced recovery" techniques can squeeze new gas out of old fields at a cost of $1.50 to $2.50 per Mcf. By 1985, gas from Alaska may eventually cost $2.50 to $2.75 per Mcf (constant 1975 dollars). Synthetic gas, or gas from shale and biological sources, may run $3 to $4 per Mcf.

The potential is great. Alaska already has 30 Tcf of proven reserves, with an additional 100 to 350 Tcf possible. Offshore reserves are estimated to be between 70 and 230 Tcf. And coal gasification from just 176 specially selected sites could potentially supply 542 Tcf.

But time is crucial. Even in well-established areas, it takes from four to eight years after the first well is drilled for a field to reach peak production. Alaskan gas will probably be transported by a pipeline that will cost more than the Alas-

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