Shuttle Launch Expected Soon

Accidents during launch preparation have resulted in several delays

The space shuttle, supposedly the workhorse of the space program for the next three decades, looks a bit mulish on the eve of its second launch. Complications and mishaps have conspired to force several postponements of its takeoff, now projected for early November. Officials of the National Aeronautics and Space Administration (NASA) say that the delay is regrettable but unremarkable because the early flights are experimental and ground crews are still inexperienced. But the prosaic nature of these troubles suggests that the shuttle might never achieve the long-standing goal of only a few weeks' time between flights.

Its tender tile skin seems to be one weak link. The latest delay was caused by the malfunction of a small but important valve that permitted a toxic chemical to spill on an area of the shuttle's belly measuring 20 feet long and about 5 feet wide. Inside of this area lay hundreds of precisely fitted tiles, glued to felt pads to insulate the craft from the heat of reentry into the earth's atmosphere. The spilled chemical, nitrogen tetroxide, is used to oxidize liquid fuel on board the shuttle so that it can maneuver in space. When about 2 gallons of it spilled during filling of a tank located just beneath the crew's cabin, it completely dissolved the bonds of about 70 tiles, which fell off and shattered. About 280 more were to be removed for cleaning and replacement. After agonizing for several days, the agency decided it could make the repairs while the shuttle remains on the launch pad. A much longer delay would have ensued if the shuttle was returned to the giant assembly building, where it would have been separated from its booster rockets and towed to its own hangar.

Earlier, a number of more minor problems had forced a 1-week postponement. A comprehensive test of the shuttle's equipment by its new pilots, Joseph Engle and Richard Truly, required several extra days. The shuttle orbiter slipped an inch during mating with its external fuel tank and booster engines, causing a brief delay. A forklift shoved a work platform against a wing and damaged several tiles. Connection of electrical and fuel lines between the shuttle's various components took longer than expected. Such mishaps and delays are likely to recur between all flights, particularly when more delicate payloads are handled. The shuttle's complexity, as well as its vulnerability to casual error on the ground, will resist attempts to operate with aircraft-like efficiency.

An understanding of this circumstance by NASA officials is thought to have played some role in the agency's decision this summer to trim the shuttle's flight schedule by 30 percent over the next 4 years, from 44 missions to 28. Two other problems contributed to that decision: a delay in production of lighter components for the shuttle so that it can hoist a number of heavy satellites into space, and the fact that NASA does not have the money to fly as many of its own satellites and science experiments as it had anticipated. More money is instead being spent on shuttle modifications and on the construction of additional orbiters. NASA is considering further flight curtailments and delays in this construction so that it can meet the demands of President Reagan's austere federal budget. Reagan, who was expected to issue a statement of support for the shuttle last month, has instead decided to wait until after the second flight.

> The shuttle may never be able to operate with aircraft-like efficiency.

The flight will be longer and more difficult than the first one on 12 to 14 April. The shuttle, with more fuel and a payload of seven scientific experiments, will weigh 7 tons more at lift-off. Consequently, it will fly a somewhat lower orbit, but will be maneuvered more while in space and during reentry so that its ability to withstand various stresses can be analyzed. The pilots will rely on the computer less and do more of the flying themselves. They will change runways at Dryden Air Force Base in California, for example, in order to land in a crosswind—an important but as yet untested shuttle capability. Engines, heaters, and computers will be deliberately turned on and off to test their resilience during the flight.

Most of the maneuvers and experiments will be packed into the first half of the 5-day mission, so that the trip's major goals will be accomplished even if it has to be cut short because of unforeseen trouble. The payload is largely designed to assess the shuttle's earth-surveying capabilities. The largest instrument will record a radar image of the earth's surface that is 50 kilometers wide. The image, of potential use to geologists searching for oil and mineral deposits, is similar to but slightly better than those obtained now by LANDSAT satellites and high-flying planes. This particular device cannot distinguish fine objects, NASA says, and therefore the Soviets need not fear an invasion of privacy when it records images over their missile fields. But the Air Force will be interested to see whether the shuttle can hold a steady attitude while the radar is operating, a capability that would permit more sophisticated civilian and military radar devices to be used in later flights. Infrared and television cameras will accompany the radar to distinguish the best spectral bands in which to operate and to distinguish between vegetation, rock, water, snow, and clouds.

A small package of scientific instruments in the shuttle's cargo bay is designed to measure dust and chemical contamination during the flight. Another experiment will measure carbon monoxide in the earth's lower atmosphere. No complete picture of the pollutant's distribution is available now. Similarly, a scanning mirror device will be used for the first time to detect the presence of pollutants and fish in the ocean by measuring chlorophyll in algae.

None of these experiments will require involvement by the shuttle pilots, beyond opening of the cargo bay doors and maneuvering the shuttle so that a view of the ground is obtained. Two other experiments will. Astronaut Truly will op-

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erate a remote manipulator arm that was constructed in Canada under supervision of the Canadian National Research Council at a cost of $100 million. The arm has three joints and extends about 50 feet. It will eventually be used for removing satellites from the payload bay and positioning them in space, perhaps for later retrieval by the same means. Supplied with a camera, it could also be used to inspect the shuttle's tiles after the launch, supplanting a more difficult in-flight inspection obtained from the ground by military cameras. The crew will practice moving the arm for a total of 13 hours during the flight. They will also control a camera inside the cockpit that can photograph lightning from thunderstorms during both day and night. NASA claims that the results might someday aid in severe-storm detection.

For several weeks during preparations for the second launch, NASA considered putting almost all of these experiments on a later flight, because of the belated discovery that pressure waves reflecting off the launch pad beneath the solid-fueled booster rockets could damage the sensitive instruments. Analysis of data from the first flight revealed that the intensity of the shock had been four times what was expected (2.4 pounds per square inch instead of 0.6). It was strong enough to cause the shuttle's wing elevons to flap and also to travel up the side of the orbiter and cause the buckling of a strut supporting a fuel tank near the cabin. If the tank had been jarred sufficiently to leak or malfunction, the crew would not have been able to orient the craft properly for landing.

NASA engineers worked intensely on the problem and devised an ingeniously simple collection of water troughs that will disperse the wave as it reflects back up through the rocket exhaust holes in the launch platform. The troughs, which are made of nylon sailcloth stretched across some rope, will disintegrate less than a second after the rockets ignite, but by that time their task will have been completed. For added insurance, the platform has been redesigned slightly so that jets will spray about 10,000 gallons of water directly into the rocket plume, further dissipating the pressure. The system has only been tested with a 10-foot scale model of the shuttle located at Marshall Space Flight Center in Huntsville, Alabama. But NASA authorities are confident that it will provide an ample margin of safety for the launch of the second flight.—R. JEFFREY SMITH

Genetic Vulnerability Down on the Farm

Bumper harvests predicted for major U.S. grain crops, but genetic uniformity of hybrids remains a cause of concern

Although never a sure thing until the corn is in the combine, U.S. Department of Agriculture (USDA) analysts are forecasting a record U.S. corn harvest this fall. A major share of the credit will go to corn breeders who developed the hybrid corn lines that have helped to more than triple average corn yields since the 1930's. But again the nation's corn farmers will have eluded the risks that go along with the benefits of the hybrid lines.

In 1970, southern corn leaf blight swept through the Corn Belt, battening on the genetic uniformity that is a product of modern corn-breeding practices. An estimated 15 percent of the crop, worth between $500 million and $1 billion, was lost as a result. Recovery, however, was rapid. American seed companies promptly provided resistant seed so that losses were largely confined to a single growing season. But the incident focused unwonted attention on the problem of genetic vulnerability in food crops and reinforced international concern that plant germplasm resources are being dangerously narrowed.

Since the blight scare, much more has been done by industry and government in this country and through international cooperation to address the problem of diminishing germplasm resources. But the adequacy of these efforts is being questioned. A General Accounting Office report* in April, for example, charged that the USDA's National Plant Germplasm System (NPGS), which is responsible for conserving the present genetic base and improving crop varieties, "lacks a sense of direction and purpose and does not have effective centralized management."

The advent of the Green Revolution and its reliance on hybrid lines has made the problem of genetic vulnerability a global one. The international dimensions of the issue will be discussed in a subsequent article. This article will focus on efforts in the United States to deal with the threat of genetic vulnerability in the period since the 1970 epidemic of corn leaf blight.

What triggered the 1970 epidemic was a mutation of the blight-causing fungus, *Helminthosporium maydis*, which had been a familiar but relatively minor nuisance in the cornfields. Corn with the so-called Texas male sterile factor in the cytoplasm—a variety widely used throughout the Corn Belt—proved acutely susceptible to the mutant fungus, and the blight spread quickly.

Conditions favorable to the epidemic were actually created by corn breeders' efforts to reduce costs and increase efficiency in the labor-intensive process of seed production. Corn breeders developed hybrid corn from open-pollinated varieties by breeding stable inbred lines with desirable traits and then crossing them to create high-yielding hybrids. Until the 1940's, seed companies had to hire thousands of high school students to help in a crucial stage in seed production. The students were mobilized to walk the cornfields and pull tassels from rows of a single-cross line, allowing pollination by another single-cross line on which tassels were left.

Discovery of a male sterile line in Texas in the mid-1940's, coupled with the identification of a restorer gene, made it possible to produce seed corn without the expensive detasseling operation. The virtual universal use of the Texas male sterile lines in the Corn Belt prompted some warnings. But since the male sterility factor was carried in the cytoplasm rather than the nucleus, plant scientists were thrown off guard.

When the blight struck, U.S. seed companies speedily planted seed lines that had been shown to be resistant to the disease in winter nurseries in Florida, Hawaii, and elsewhere to produce seed. Detasseling operations had to be

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