Shuttle engine may delay first flight

Technical problems and a lagging test schedule for the main rocket engine of the space shuttle may result in — and indeed necessitate — delaying the shuttle's maiden flight into space, according to a committee of the National Research Council. The first orbital mission has been tentatively targeted for March 1979, though the National Aeronautics and Space Administration has already been preparing for a possible delay into June.

"While many elements of the engine development point to the ultimate success of the program," says the committee's report, "incorporation of [needed] changes and the tests to assure their effectiveness could result in delays. The ambitious timetable may have to be extended to avoid a first manned orbital flight with a high risk factor."

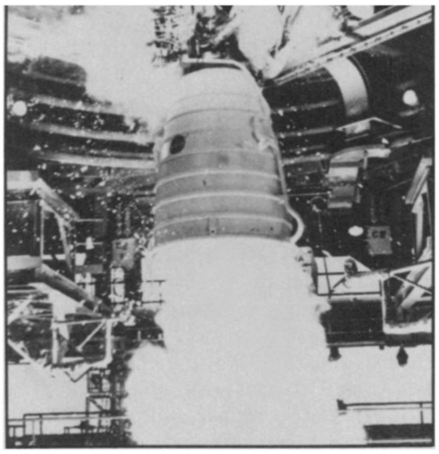
The development program was late from the day it started, the report indicates. The engine contractor, Rocketdyne Division of Rockwell International Corp., was not authorized to proceed with development until nine months after it was selected for the job. Engine system testing began in June 1975, "nearly 15 months later than the original schedule." The engine was first tested at its rated power level in March 1977; a year later, only 11 minutes of rated-power operation had been achieved, says the report, compared with a single typical flight's expected requirement of about eight minutes of operation, most of it at rated power or higher.

A number of technical problems have plagued the engine's development, most of them involving the turbine-driven centrifugal pumps that deliver the liquid hydrogen and liquid oxygen propellants to the combustion chamber under high pressure. Examples cited by the NRC panel include "high vibration-induced stresses in the ... turbine blades, major leakages through shaft seals in the high-pressure oxygen pumps, inability of the fuel pump to operate at the inlet propellant pressures for which it was designed, and low efficiencies [that] result in increased power requirements and thus increased turbine inlet temperatures to ensure adequate pump delivery."

The committee's report, prepared at NASA request after a request to the space agency from the Senate Subcommittee on Science, Technology and Space, makes several specific technical recommendations — design of a new shaft and housing for the oxygen pump, alternative-design studies of the heat exchanger, etc. It also calls for Rocketdyne to take an entire additional engine and its "critical parts" from those currently regarded as production engines for use in additional testing.

Much of that testing, the committee feels, should have provided necessary data by late summer or early fall of this year. At present, says the report, "it is too early to predict the exact timing of the first manned orbital flight," but the additional data will make it possible "to plan the first flight schedule more realistically. Because of the number of critical milestones yet to be achieved, the committee recommends that the schedule be reviewed at that time."

The space agency has been considering using the third shuttle orbital flight, originally targeted for October 1979, to raise the orbit of the now-descending Skylab space station. The delay raises a question of shifting to flight number 2. □


NASA

Firing of space shuttle test engine.

Probing with Cerenkov light

Electromagnetic radiation (light, X-rays, etc.) is traditionally used to study the structure and dynamics of atoms and molecules. Atoms and molecules absorb particular resonant wavelengths as they undergo particular changes in structure and behavior, and so the study of the resulting absorption spectra yields information on the physical characteristics of the different chemical species.

In these studies it is especially pleasant to have available a light source that is tunable over a wide range of wavelengths. A good deal of such work is now being done with synchrotron radiation, the radiation produced by accelerated electrons as they move in orbits caused by magnetic fields. The synchrotron radiation now used is mostly in the X-ray range. For the study of gaseous molecules, in many cases ultraviolet light is desirable. At Stanford University, a team led by Richard H. Pantell has developed a method of producing light in the vacuum ultraviolet range by using the Cerenkov radiation of accelerated electrons. Cerenkov radiation is produced by accelerated particles traveling through a material substance at speeds greater than the speed of light in that substance. (The speed of light in matter is lower, and sometimes significantly lower than is its speed in a vacuum.) The Stanford apparatus runs the electrons through a 22.1 foot cell containing helium to produce the radiation. □

A metal sponge for hydrogen fuel

Hydrogen burns. That's why water exists. That's why zeppelins never became popular. It burns with a hot, smokeless, nonpolluting flame. As the most abundant chemical element in the universe, it represents an ideal potential fuel, provided it can be made, stored and handled conveniently.

Hydrogen can be generated from coal. (It can also be generated by electrolysis of water, as everyone who ever "invented" an automobile engine to run on water has pointed out, but that method is costly and slow.) The major problem is ways of storing hydrogen. Keeping it as a gas takes space and presents safety hazards. Keeping it as a liquid takes a lot of energy to establish and maintain the ultracold (under 18° K) temperatures required, and thus lowers the energy gain and also presents safety problems. The most practical way of storing hydrogen appears to be by chemical bond, most likely in the form of a metal hydride. At the recent joint meeting of the American Physical Society and the Biophysical Society in Washington, J.J. Reilly of Brookhaven National Laboratory described studies of these possibilities.

The best chemical form for storing hydrogen now appears to be in a metal hydride. Certain metals and alloys of metals have the ability to take up hydrogen like a sponge. Under proper conditions of temperature and pressure, hydrogen atoms will take up places inside the crystal structure of the metal and form a hydride. The compounding is reversible. Lowering the temperature and pressure causes the hydrogen to break loose from the metal and percolate out. The metal can be used over and over again as a storage bin.

In the distant future, says Reilly, hydrogen may be the only portable fuel available, and so research in metal hydride storage is an important endeavor. It offers more advantages than safety and stability. The hydrogen density in a metal hydride is greater than that of liquid hydrogen and about ten times that of hydrogen gas at 100 atmospheres pressure. Not all metals that form hydrides are useful for the purpose. At the moment an iron-titanium mixture seems best. The two metals are cheap and abundant, and the hydrogen can be put in and taken out at room temperature.

In fact, there are already a few technological uses of iron-titanium-hydride being investigated. The Public Service Electric and Gas Company of New Jersey is using it to store energy by making iron-titanium-hydride with electricity during low-demand periods and then using the hydrogen to give back electricity in peak periods. The Daimler-Benz Company has an automobile that runs on it, and the Billings Energy Company is using it to power a Winnebago bus. □