

fied that they had no time for such studies because they were always too busy preparing for the next flight. This disturbed the commission members, who noted that shuttle program resources were continually "strained to the limit" and focused far too much on near-term difficulties.

The commission ultimately concluded that the program would have been slowed or interrupted for a variety of economic and safety reasons, even if the accident had not occurred. But the mistakes all came home to roost only a few milliseconds after the Challenger was launched, when a leak of hot gases through a booster seal generated the first of 9 distinct puffs of black smoke (not just one, as previously reported), corresponding roughly to natural flexing of the rocket casing. It apparently erupted at the coldest point on the joint, according to the report. Even now, experts are unsure if the leak was continuous or momentarily plugged by debris from the gasket and putty combustion. But 58 seconds into the flight, after some severe wind shear was encountered and the thrust of the boosters sharply increased, the first flickers of flame appeared between the orbiter and an enormous external fuel tank.

The flame was deflected down and around the booster rocket and onto the surface of the external tank, as well as onto a strut connecting the two. A portion of the tank containing liquid hydrogen was breached in the 64th second, creating a "bright, sustained" glow on the Challenger's belly, memorable in later slow-motion television pictures. Moments later, the strut was detached, the hydrogen tank seriously ruptured, and a membrane isolating a tank of liquid oxygen was breached. Almost simultaneously, the loose rocket booster struck the same tank, exacerbating the damage and causing the Challenger to be "totally enveloped in an explosive burn," the report says.

"There was nothing that either the crew or the ground controllers could have done to avert the catastrophe," the commission noted, pointedly fixing the blame elsewhere. The failure may have been exacerbated by the presence of ice in the joint, deposited when the rocket was exposed to seven inches of rain while sitting for a month on the launch pad. It might also have been exacerbated by the presence of debris and contamination in the seal, or the fact that the gaskets were subjected to unusual pressures during and after assembly. But these were not the principal cause, the report suggests.

One of the commission's recommendations is that the rocket joint and seal be redesigned under the supervision of the National Research Council. Another is that an independent safety organization be estab-

lished within NASA to conduct oversight and report problems directly to the administrator. Perhaps most important, it says, NASA must "establish a flight rate that is consistent with its resources."

At a press conference on 9 June, NASA Administrator James Fletcher declined to

endorse any of these specific ideas. But he promised that "where management is weak, we will strengthen it; where engineering or design or process need improving, we will improve them." The conclusions, he said, "are not unexpected and certainly not entirely undeserved." ■ **R. JEFFREY SMITH**

## Science Adviser Named

President Reagan has nominated William R. Graham, currently deputy administrator of the National Aeronautics and Space Administration, to be his science adviser and director of the Office of Science and Technology Policy (OSTP). Graham, 48, has spent most of his professional life as a defense analyst, first with the RAND Corporation and since 1971 with R&D Associates, a California company he co-founded.

The appointment has been greeted with less than total enthusiasm by members of the science policy establishment, who were hoping to see a better-known scientist installed in the job. However, several prominent industrial scientists who were sounded out for the post said they were not interested, and a search has been going on halfheartedly since the previous incumbent, George A. Keyworth II, left on 1 January to start a consulting company.

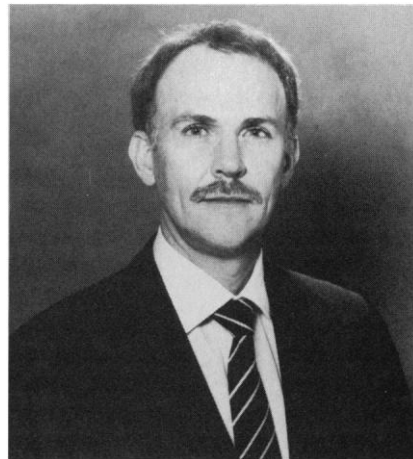
In the meantime, the job was filled on an acting basis by John P. McTague, who informed the White House 3 months ago that he would be leaving for a top research job at Ford Motor Company. Finally, McTague decided he could not hang on any longer and left Washington on 23 May.

Graham, who has a B.S. degree from California Institute of Technology and a Ph.D. in electrical engineering from Stanford, has had a short and stormy tenure at NASA. He was confirmed as deputy administrator on 22 November last year. Within days, he was elevated to acting administrator when James Beggs took a leave of absence to defend himself against charges of fraud arising from allegations of contract mismanagement when he was a top executive of General Dynamics Corporation. Six weeks later, the shuttle Challenger exploded.

Beggs is reported to have opposed Graham's nomination to the number two job because of his lack of management experience, and Graham never won the support of NASA's senior officials. To make matters worse for Graham, Beggs maintained an office in NASA for several weeks after he took a leave of absence. When Beggs finally resigned, Graham was passed over for the job, and the White House instead nominated James C. Fletcher. Graham then went back to being deputy administrator, but it was widely assumed that Fletcher would eventually bring in a deputy of his own choosing. The White House has paved the way by moving Graham to OSTP.

Graham has been a consultant on a variety of weapons programs for the Defense Department and in 1980 worked on Reagan's transition team for DOD. He is said to be a firm supporter of the Strategic Defense Initiative (SDI). He served as chairman of the President's General Advisory Committee on Arms Control and Disarmament from 1982 until his appointment to NASA last year.

His nomination to be director of OSTP requires confirmation by the Senate Committee on Commerce, Science, and Transportation. Hearings have not yet been scheduled. Approval is expected, though he is likely to get tough questioning from some Democrats on the committee who oppose SDI. ■ **COLIN NORMAN**



**William Graham:** *Going to OSTP after a brief and stormy tenure at NASA.*