

Challenger Disaster: 'Rooted in History'

Two distinct causes led to the Jan. 28 explosion of the space shuttle Challenger, according to the findings of the presidential commission that has just spent four months investigating it. One is a specific technical flaw, likely to lead to the redesign of the shuttle's solid-rocket boosters. The other is far more widespread — a set of attitudes and management philosophies that kept the technical problem from being remedied despite nearly a decade of warnings, and which may result in the redesign of NASA itself.

The 13-member commission's investigation resulted in some 15,000 pages of transcript from public and closed sessions, as well as the compilation of more than 6,300 documents totaling about 120,000 pages more, plus hundreds of photographs and the results of numerous specially conducted tests. One staff member quoted by Associated Press said that more than 6,000 people were involved in one way or another with the investigation, which cost "in the \$2 million to \$4 million range."

The technical culprit, as expected, turned out to be the O-ring seal between the rearmost segments of the shuttle's right-hand solid-rocket booster (SRB). The failure, concludes the commission's 256-page report released June 9 (four more volumes of supporting material will be released in coming weeks), "was due to a faulty design unacceptably sensitive to a number of factors."

Included among these were temperature — Challenger's Jan. 28 liftoff took place in the coldest weather of any of the 25 shuttle launchings ever conducted — and "the character of materials." The temperature at the point on the SRB's circumference from which hot exhaust gases began spewing forth and led seconds later to the explosion was estimated at $28 \pm 5^\circ\text{F}$. And the O-ring's resiliency, affecting its ability to maintain a tight seal when initially compressed out of shape, "is directly related to temperature," notes the report. Measurements cited by the commission, in fact, showed that "a compressed O-ring at 75 degrees Fahrenheit is five times more responsive in returning to its uncompressed shape than a cold O-ring at 30 degrees Fahrenheit." The O-ring, in other words, did not rebound quickly enough to keep in the hot fumes from the propellant firing just inside it.

The faulty joint and its seal must be changed, says the report, though the commission made no recommendation of a particular design. "No design options should be prematurely precluded because of schedule, cost or reliance on

existing hardware." An advisory panel has been formed by the National Research Council to advise on the process, in response to a request from NASA administrator James C. Fletcher. This paralleled a recommendation from the commission urging that Fletcher send a progress report to the president in a year.

But modification of the SRBs is only the nuts-and-bolts detail of the commission's findings. Far more damning are its conclusions that prelaunch misgivings by engineers from Morton Thiokol, Inc., the SRBs' builder, never found their way to top NASA management who might have postponed the launch, and furthermore, that the explosion that killed seven people was what the report labels "an accident rooted in history."

Thiokol was selected on Nov. 20, 1973, from among four competing contractors to build the SRBs. The NASA board that made the choice noted in its report only three weeks later that Thiokol had finished last of the four in the "design, development and verification factor." However, the company finished first in the "management factor" and second in the "manufacturing, refurbishment and product support factor," and the board's report described Thiokol's O-ring approach as "an innovative design feature" that "increased reliability and decreased operations at the launch site, indicating good attention to low cost . . . and production."

During a 1977 test of the rocket motor, Thiokol discovered during a simulated firing of the engine (using pressurized water) that the joint incorporating the O-ring was "opening rather than closing as our original analysis had indicated," according to testimony before the commission by a company official. At that time, Thiokol engineers, says the commission report, did not believe (as some of them would by the 1980s) that the test results really posed a significant problem, and reported them to NASA's Marshall Space Flight Center in Huntsville, Ala., which was responsible for the SRB design and development.

Reaction from Marshall, says the report, was "rapid and totally opposite of Thiokol's," resulting in a memo in which the chief of Marshall's Solid Rocket Motor (SRM) Division said, "I personally believe that our first choice should be to correct the design in a way that eliminates the possibility of O-ring clearance." The memo called the finding a "design deficiency" and "a very critical SRM issue." About seven weeks later, a report from another Marshall engineer characterized "no change" in the design as "unacceptable," and subsequent documents

to higher-level Marshall management continued to press the point. Yet no change was either sought by Marshall or initiated by Thiokol, even when the shuttle's second flight, in 1981, revealed evidence of O-ring erosion.

The lack of communication of the recurring problem, particularly while the shuttle was being driven toward ever more frequent flights, is characterized by the commission's report as "the silent safety program." The commission's second recommendation — right after the redesign of the SRBs — is a tightening of NASA's management structure, placing the responsibility directly in the hands of the shuttle program manager instead of in what have been the relative autonomies of Marshall and NASA's other field centers. In addition, the commission adds its voice to the growing chorus of calls for expendable launch vehicles to supplement the shuttle. Yet NASA's budgets are still tight, and the timetable for a U.S. return to space is, if anything, murkier than ever.

— J. Eberhart

NASA's Graham to be science adviser

President Reagan last week announced he will name electrical engineer William R. Graham as his new science adviser. Currently, Graham is deputy administrator of NASA. The advisory post, which requires Senate confirmation, would also make Graham head of the White House Office of Science and Technology Policy.

"Long overdue" is how Philip Speser, executive director of the Washington, D.C.-based National Coalition for Science and Technology, greeted the Graham announcement. Speser was referring to the fact that it has been six months since George A. Keyworth II resigned both posts to start a consulting business (SN: 12/7/85, p. 358). Speser, who heads the only registered lobby of scientists on science policy, says that "under the Reagan administration, the science adviser has changed from being more of a spokesperson for science in the White House to more of a spokesperson for the White House to the scientific community." He adds, "We all hope that Dr. Graham will reopen more of a two-way channel of communications."

Graham is a founder of R&D Associates in Marina Del Rey, Calif. Graham has described his activities there and while on the staff of the Rand Corp. in Santa Monica, Calif., as involving primarily work on strategic missile and aircraft