Shuttle Setback

On 29 December, just one day before the shuttle's redesigned booster rocket was to leave a plant in Utah for shipment to the launch pad in Florida, engineers discovered a critical flaw in the nozzle. Now the rocket motor must be torn down and analyzed, a process that will take "a couple of weeks," according to officials of the National Aeronautics and Space Administration (NASA). Because the shuttle is running on a very tight schedule again, the problem immediately triggered a delay of the next launch, which was set for 2 June.

The extent of the delay is not known as yet. Dom Amatore of the Marshall Space Flight Center in Huntsville, Alabama, says it could last "several months." Too little is known about the problem to make a firm prediction.

Meanwhile, the manufacturer, Morton Thiokol of Brigham City, Utah, hopes to put the situation in the best light. "It's not a safety-of-flight issue," says Rocky Raab, a company spokesman. "An in-flight failure would not have been detected until afterwards, as it was in this case," he says, referring to the fact that a week passed between a test firing of the rocket on 23 December and the discovery that the "outer boot ring" on the nozzle had failed.

The outer boot ring is a flexible strip of carbon material that surrounds the nozzle attachment area inside the rocket cylinder. It is a barrier against the burning gases produced during ignition. Its purpose is to protect a swivel gear that can move the nozzle a few degrees and steer the vehicle on takeoff. Like other parts of the nozzle, the boot ring has caused some concern in the past. According to one engineer, Thiokol found that the boot ring had worn unevenly on earlier shuttle flights, and, for this reason, took advantage of the hiatus in shuttle flights to refashion the part. A new design was included in the first full-scale test of the rocket on 30 August, with great success. A different design was used in the December test.

Thiokol initially judged the recent test a success, but when technicians climbed into the empty rocket several days later they discovered that a four-foot section of the boot ring was missing. A piece more than a foot long was found lying inside the rocket.

According to NASA officials, this test may have put an unusual strain on the boot ring. The nozzle was pointed seven degrees off center, stretching the boot ring to the maximum extent—further than in any other test and further than in a normal launch. Whether or not this caused the failure is not known.

On the same day the nozzle failure was disclosed, Morton Thiokol was hit with another disaster. Five workers were burned to death at a plant near Promontory, Utah, where the first stage of an Air Force MX missile was being assembled. Although the investigation has just begun, early reports indicate that the rocket fuel in the bottom of the missile ignited as workers were removing a mold from the center. (The fuel for solid rockets is poured and then allowed to set like Jello.) Workers may have created an electrostatic spark as they removed the mold.

NASA immediately halted the assembly of shuttle rocket segments pending an investigation of the MX accident. Although the MX and the shuttle boosters use slightly different fuels, the assembly process is similar enough to cause concern. One NASA official says the impact of the MX disaster is a "moot point" because the nozzle problem has already delayed the next launch. But other observers say that if the MX accident investigation finds anything other than a careless mistake, it may be necessary to make changes in Thiokol's rocket assembly process—a potential cause of delay.

According to Raab, Thiokol has stopped pouring rocket fuel for the moment. The shuttle booster segments that have already been unmolded and readied for shipping will be sent to Florida right away, except for two that include the nozzles. These will be held until a decision is made on what to do next. According to NASA, it may be possible to replace the failed boot ring with the design that worked successfully in last August's test. But if it becomes necessary to redesign and test this part, the shuttle may be on the sidelines longer than expected.

The crowded manifest for the shuttle issued by NASA last October thus becomes somewhat tighter. NASA may have to postpone or sacrifice important scientific payloads once again, and one space scientist expects to see "more blood on the floor before long." ■ **ELIOT MARSHALL**

who was teaching a course last semester and who also commutes weekly to Fermi National Accelerator Laboratory. There was "no way" that committee members could read each site proposal completely, he says. "Everybody read the introductory chapters," he adds, and then focused on particular chapters in their areas of specialization.

The academy committee was broken down into seven working groups covering issues such as geology and tunneling, costs, environment, and regional infrastructure. Committee members did not have time to check the accuracy of the proposals. Tschinkel says that committee members had to accept state data at face value.

No single numerical evaluation was used to drive decisions because of the complexity of the undertaking, but various rating methods were employed to guide committee deliberations, the academy says. None of these statistical exercises appear in the academy's decision document. Nor is there any presentation of DOE's cost estimates for constructing and operating the SSC over a 30-year period at various sites. Life-cycle costs, academy officials say, varied only a few percent between sites. The economic evaluations of proposed sites were performed for the committee by a DOE contractor.

The academy group offers no specific explanations for excluding sites from its list. "The very nature of this process," says the panel report, "does not permit determination of the extent to which any specific factor or combination of factors influenced how individual judgments were formed." Edward A. Frieman, the chairman of the selection committee, has asked members not to talk about losing proposals.

The committee report does indicate, however, that many states were knocked out on the basis of geological factors and regional resources, the first and second most important items on DOE's list of site selection criteria.

Schwitters says he can understand some states being upset. "These states put in a tremendous effort. Their proposals were really good." He says that evaluations of site proposals might have been more thorough if DOE had allotted more time. Site visits, which DOE prohibited, might have altered the final list, he adds. The committee, in fact, notes in its report that site visits would have been useful.

Nevertheless, Schwitters and Tschinkel say the panel's decisions were impartial. "I was satisfied that the level of information was sufficient for us to make good decisions," says Tschinkel. What remains to be seen, she notes, is whether Congress will perceive the academy's recommendations as being fair. ■ **MARK CRAWFORD**