low-up (at least 3 to 5 years) as a precondition for participation in the study. Second, they will have to agree to an autopsy in the event of death.

At the present time, the NIH has received no gene therapy protocols. However, it is gearing up the necessary administrative apparatus in expectation that one or more will be coming before long. There are five laboratories in the United States that, at present, are pursuing research that will lead to human gene trials. When they are ready to go, their research protocols will undergo one of the most extensive reviews any research has been subjected to.

Approval from the investigators' local Institutional Review Board and Institutional Biosafety Committee must precede submission to the NIH Working Group. Its review will be followed by a review by the full Recombinant DNA Advisory Committee, which then will forward its opinion to the director of NIH for his final review.

At all federal stages, this process will take place in the open. Not only will NIH committee meetings be open, a précis of the protocol itself will be published in the *Federal Register* for public comment.

Some Working Group members have been struck, in the process of revising their "points to consider," by the fact that public comment has been minimal. Only 14 letters were received, some of them from federal agencies providing an official response. One group member reports that there has been consideration of setting aside an additional period for public comment to preclude allegations that the draft document was somehow rushed through. Conspicuous by their silence were signers of a petition that activist Jeremy Rifkin wrote nearly 2 years ago, protesting the extension of recombinant DNA technology to medical genetic intervention (*Science*, 24 June 1983, p. 1360). Each signer of that petition was sent a copy of the points to consider document. None, except Rifkin himself, replied. He criticized the present Working Group as "not broad-based enough in its professional composition," saying, for instance, "There are no anthropologists, sociologists, psychologists, or theologians. . . ." The Working Group may decide to create special subgroups to deal with special issues as needed when it feels the need for greater expertise in certain areas.

The next stage in the policy process will be a review of the revised guidelines when the Recombinant DNA Advisory Committee meets at NIH on the third of May.—**BARBARA J. CULLITON**

Shuttle Encounters Landing Trouble

As the shuttle Discovery returned on 19 April from its fourth visit to space, it encountered unusually serious, but not entirely unexpected, landing trouble. The touchdown itself went smoothly, but as the shuttle braked to a stop, first one of its main wheel sets locked and then another, causing a blowout of one tire and the shredding of another. Had the lockups occurred earlier, when the shuttle was rolling more quickly, all four main tires might have failed, and disaster would have ensued.

No one was immediately certain what caused the mishap, but suspicion centered on the shuttle's brakes and landing gear, components that have long been plagued with problems. National Aeronautics and Space Administration (NASA) officials claim that the brakes and landing gear have worked relatively well during the first 16 flights, suffering only a few broken parts. "No flight safety issue exists with the current design," the agency concluded after a special review last summer.

A different picture emerges from the annual reports of the program's independent auditors, a group known as the Aerospace Safety Advisory Panel. As long ago as January 1982, the panel—composed of nine experienced aeronautical engineers—concluded that the margin of safety for the landing gear was low, and noted that the "design is such that should a tire fail, its mate (almost certainly) would also fail—a potential hazard." As predicted, both of the Discovery's right main tires experienced serious damage at roughly the same time.

In January 1983, the panel again noted that "the landing gear tires and brakes have proven to be marginal and constitute a possible hazard to the shuttle." It recommended three major modifications, each of which has been resisted by cost- and schedule-conscious shuttle program managers. First, it recommended that the brakes, which are manufactured by the B. F. Goodrich Company, be replaced or significantly upgraded. "There have been actual or incipient brake failures on almost every landing even though landing weights have not yet approached the design maximum," the panel said. The risks have increased over time because shuttle pilots have steadily demanded more braking power. During the Discovery's latest landing, for example, the braking force on one tire set reached 41 million foot pounds, well beyond the average for previous flights.

Second, the panel recommended that program managers install a mechanism for automatic braking, relieving the pilot of a fairly arduous task during "a period of high strain." Such mechanisms are already installed on 747, DC-10, DC-9, and other jetliners, the panel noted. "Adaptation for use on the shuttle should be a simple process and would relieve crew workload and result in shorter, consistent stopping distances."

Third, the panel recommended that steps be taken to reduce the shuttle's landing speed and to relieve stress on the rear wheels. Specifically, a small wing, known as a canard, should be attached near the nose, the forward landing gear should be lengthened, and the number of rear tires should be doubled, the panel said.

Although the agency has expressed a willingness to study the problems further, it is notably unenthusiastic about the suggested reforms. Doubling the number of rear wheels would require a larger wheel compartment, the agency concluded last August, which in turn would require wing modifications. Lengthening the nose gear would cost $50 million and take 3 years. Adding a canard would require redesign of the fuselage, and various flight controls, resulting in significant schedule delays. "Future generation vehicles will include consideration of canards," the agency said.

In January, the advisory panel said that it accepts the impracticality of adding a canard, but urged NASA "to continue to seek other, more readily adaptable solutions." For the moment, the agency has decided only to install additional brake and landing-gear sensors, to modify a few brake parts, and to make it somewhat easier for the pilot to depress the brake pedal. Additional reforms may result from study of the Discovery's mishap.—**R. JEFFREY SMITH**