sponsibility on the issue of humankind's very existence."

The statement, which was addressed "to all people of goodwill, above all to scientists," repeated the conclusion reached by an international consortium of scientific academies last September. "Basing ourselves on the knowledge which we as scientists have, and proceeding from the understanding of the very nature of nuclear weapons, we declare in all responsibility that there are no effective defensive means in a nuclear war, and their creation is practically impossible." Similar views have been expressed by the U.S. National Academy of Sciences (NAS), the Académie Française, and the British Royal Society, among others.

Although the *Tass* article listed no affiliations for those who signed the statement, sources in the United States say that the top echelon of Soviet science is represented. According to an expert at NAS, for example, the signers include the president of the Soviet Academy of Sciences, many members of its presidium, and a sprinkling of Soviet Nobel laureates. "It's the first team," the NAS expert says.

"On our part, we are firmly convinced, and this conclusion has been made on the basis of a strict scientific analysis of all aspects of that problem, that nuclear disarmament is the only way on which the states and peoples can ensure true security," the statement reads.

Meanwhile, George Keyworth, the President's science adviser, has lashed back at U.S. critics of the President's plans. Keyworth, who played a major role in shaping the antiballistic missile proposal, told the Electronic Industries Association on 20 April that the criticism came from "self-appointed spokesmen" who were trying to stifle "a potentially world-changing opportunity." He said that the reaction of physicists in particular was disappointing. "Some pointed out deficiencies in systems not yet invented. Others declared outright that the task is forever impossible. . . . I find those to be strangely dogmatic positions for seekers of knowledge to adopt."

Keyworth said that he "couldn't believe" these are representative views, and he urged members of the audience to speak up, in order "to widen the debate." The best analogy for the ABM effort is the long-running struggle to extract usable energy from controlled thermonuclear fusion, he added. "Even after 32 years and billions of dollars, I'd be surprised if we were even halfway to our goal—and no one can tell us yet how we're going to achieve it. But we have hope that we can develop the technology eventually—and the goal is too important not to try to reach."—**R. Jeffrey Smith**

Research Council Questions Shuttle Launch Projections

The National Aeronautics and Space Administration's (NASA's) chances of meeting its goal of 30 space shuttle launches per year by 1990 are "impossible or highly improbable" with the four-orbiter fleet currently funded, and only "marginal" with a five-orbiter fleet, according to a newly released National Research Council (NRC) report.* Because the shuttle operates so near to its design limits, the report says, delays and unexpected repairs—exacerbated by the shortage of spare parts—will pose severe constraint on launch rates.

The NRC's conclusions have obvious implications for the funding of a fifth orbiter, which NASA ardently and unsuccessfully fought for last fall (*Science*, 18 March, p. 1299). At the moment, however, the number of orbiters is far from the most serious constraint on the program. NASA's current facilities for refurbishing the reusable solid rocket boosters, for example, are barely adequate for sustaining 18 flights per year.

Similarly, a rate of 24 flights per year will begin to put severe strains on the inventory of space shuttle main engines. Nineteen engines are planned, which is "barely adequate," according to the panel. Indeed, the inventory will be entirely *in*adequate unless NASA starts a major spares program, especially for the high-pressure liquid hydrogen and liquid oxygen turbo pumps.

Of particular concern to the panel are the implications of closing the space shuttle production lines after the fourth orbiter (Atlantis) is completed in 1984. Restarting the production lines would be a formidable task, seriously hampering NASA's ability to react to a major shuttle accident. The production time of an orbital wing, for example, would increase from 6 months to 36 months.

Finally, one of the most fundamental constraints on the launch rate is the need to give each orbiter a generous allotment of downtime for maintenance and repair, as is done in the airline industry. NASA now plans 5 months of downtime for every 25 flights. The NRC feels that a more prudent rate would be 5 months every 15 flights, at least in the early years.

Taking everything together, and assuming that money becomes available for all the necessary hardware and logistics support, the panel concludes that a fleet of four orbiters could plausibly support 17 to 25 launches per year by 1990 (versus NASA's plan for 30), while a fleet of five orbiters could support 22 to 31 launches.

These figures, so much more pessimistic than NASA's, seem to have provided ammunition for both sides of the fifth orbiter question. This is largely because the NRC report only addresses the shuttle's capability for launch, and explicitly ignores the far more nebulous question of long-term demand for shuttle services. Since no one really knows what the demand will be, optimists can believe in expansive projections and claim that a fifth or even a sixth orbiter is absolutely essential. Their response to the NRC report is typified by one congressional staffer who said: "We've already spent $15 billion on the space shuttle. Why not spend another $3 billion to make the system work right?"

But to skeptics such as presidential science adviser George A. Keyworth and budget director David Stockman, the report simply bears out their suspicion that the purchase of a fifth orbiter would commit them to large, additional expenditures on spares and logistics support. They would rather restrict the four-orbiter fleet to military and civil missions, while selling off NASA's expendable launch vehicles to entrepreneurs who would then go after the commercial payloads.

Clearly this is not a question to be resolved solely by technical analysis.—**M. Mitchell Waldrop**

**Assessment of Constraints on Space Shuttle Launch Rates* (National Academy Press, Washington, D.C., April 1983).