Nuclear Devices Tested by India and Pakistan Perplex Scientists and Shake Prospects of CTBT

On 11 June, the symbolic Doomsday Clock on the cover of *The Bulletin of the Atomic Scientists* was reset to 11:51—closer to midnight than at any time since the cold war ended in 1991. In that year the minute hand was pushed back to 11:46. Since its introduction in 1947, the clock has been a metaphor for the fear that nuclear weapons would blow the world away. The change last month followed the tests of nuclear devices by India and Pakistan in May and dramatizes, as the *Bulletin*'s board of directors put it, "the failure of world diplomacy in the nuclear sphere, the increased danger that the nonproliferation regime might ultimately collapse, and the fact that deep reductions in the numbers of nuclear weapons, which seemed possible at the start of the decade, have not been realized."

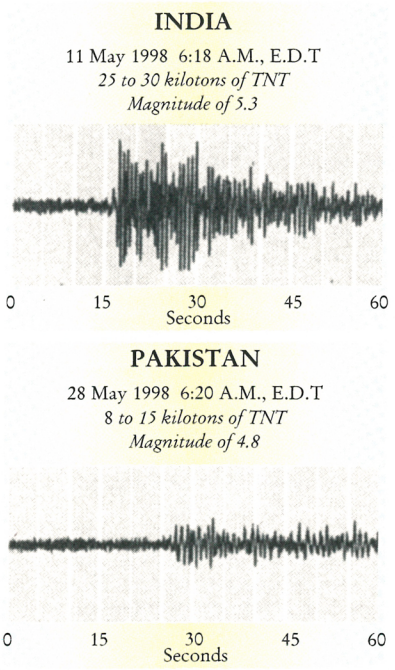
The tests by these two hostile nations represent an unprecedented peril. The countries are unlike the cold war adversaries, the US and Soviet Union. India and Pakistan have fought three wars and numerous skirmishes across a long common border, with their territories overlapping in the rugged mountains of northern Kashmir and Jammu, which are claimed by both sides. The very existence of India and Pakistan as separate states is the result of the intense hatred between Hindus and Muslims that flared long before the countries were granted independence by Britain in 1947. Both nations, though under severe economic strain, chose to divert resources and devote some of their most able scientists and engineers to the development of nuclear weapons and delivery systems.

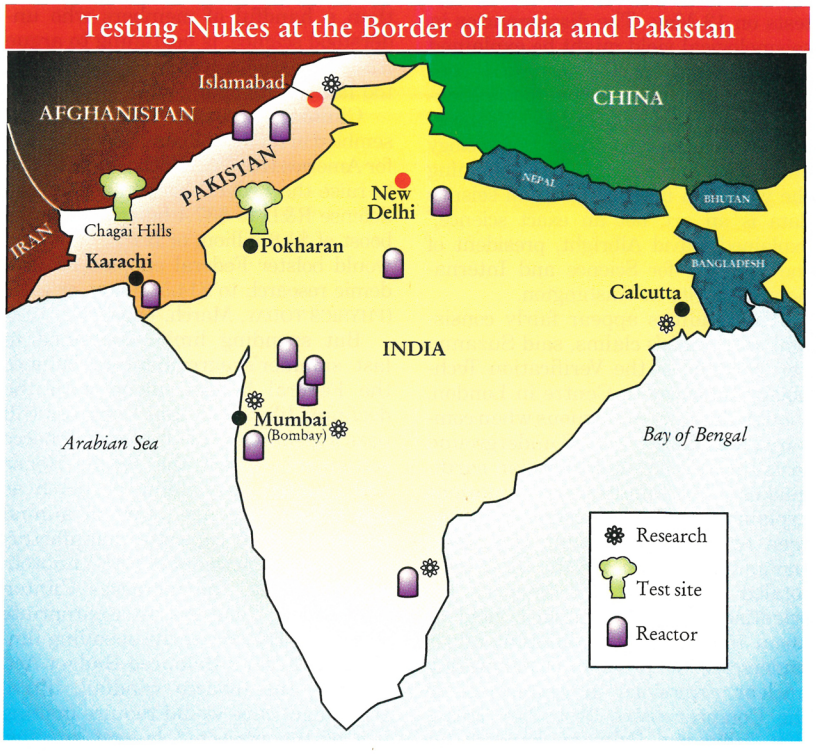
The shockwaves of India's three tests on 11 May jolted the world. Although intelligence agencies had monitored India's Pokharan test range for years, they missed the preparations for these tests, resulting in wide criticism of the customary watchdogs. It was Prime Minister Atal Bihari Vajpayee, elected only three months earlier, who announced that India had conducted underground tests of a fission device, a low-yield device and a thermonuclear device, and that no radioactive material had vented into the atmosphere. Then, 48 hours later, Vajpayee revealed that India had set off two more low-yield nukes.

Equally disturbing were the tests by Pakistan on 28 May, when it exploded five devices. On 30 May, the country conducted a sixth test. Pakistan had been under intense surveillance after India's tests, especially once Prime Minister Nawaz Sharif had declared that "Pakistan has the right to take any steps essential for security." But when Foreign Minister Gohar Ayub Khan added that Pakistan has the technical capability to match any threats, it all but confirmed what many nations had long suspected: Pakistan can make atomic weapons. Only two weeks later, the tests in the Chagai Hills corrected any doubts.

Even though many anomalies and ambiguities clouded the exact number and yield of the tests in both countries, the reality was that India and Pakistan had joined the Nuclear Club and had upset the elaborate balance of international treaties and laws.

After nearly a week of silence, Indian physicists and politicians held a 70-minute press conference on 17 May in New Delhi to discuss the technical details. Rajgopala Chidambaram, a physicist and chairman of India's Atomic Energy Commision, reported that the tests were of a 12 kt fission





device (a lighter and more compact version of the country's first ever device, tested in 1974), along with a 0.2 kt device and a 43 kt thermonuclear device. The distance separating the shafts of the two largest tests was 1 km. According to Chidambaram, the thermonuclear shot was not a "boosted" fission device, but used a fission explosion to trigger a fusion blast. The low yield was deliberate to avoid damaging a village 5 km from ground zero. Later, Chidambaram told an Indian TV interviewer that scientists could have produced a 200 kt thermonuclear device, but decided against it for strategic and environmental reasons. The two tests on 13 May had yields between 0.2 and 0.6 kt, said Chidambaram.

Soon after the tests on 11 May, the Incorporated Research Institutions for Seismology (IRIS) reported a single event with a magnitude of 4.7 (on the Richter earthquake scale), which equals a yield of about 20 kt, with an uncertainty factor of 2 or so. The prototype International Data Centre (pIDC), using reports from 62 seismic stations, identified a single event with body-wave magnitude (mb) of 4.7, and more detailed US Geological Survey (USGS) results, based on data from 125 stations, indicated 5.3 mb, suggesting a yield of 25 to 30 kt for the pIDC and 30 to 60 kt for the USGS. The seismic data indicate only one event, not three separate explosions on 11 May, though the 0.2 kt device was probably too small to measure. No signals were detected for the small tests on 13 May. The discrepancies in seismological yield might be explained by differences in the assumed constants in the yield relative to the Richter signals, the announced yield is incorrect or the data do not take the geology of the site into account. "Determining the yield of a nuclear test from seismic data is an art, not an exact science," explained David Albright, president of the Institute for Science and International Security in Washington.

The readings appear fairly consistent with India's claims, said Suzanna van Noyland of the Verification Technology Information Centre in London, though they are "ambiguous when compared with datasets of US underground tests [in Nevada] and Eurasian earthquakes." The simultaneous explosions explain why only one seismic event was seen by scientists around the globe. Indian officials claimed the three tests totaled 55 kt, but US weapons lab scientists put the combined yield at about 15 to 25 kt. The different values underscore the problem of monitoring nuclear explosions—a centerpiece of the Comprehensive Test Ban Treaty that India and Pakistan have so far refused to sign.

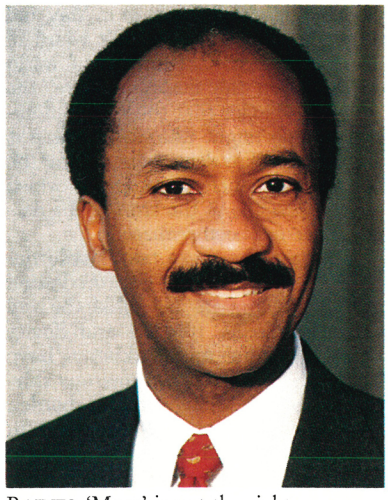
At their press conference, the scientists refused to describe the types of fission materials or the components of the thermonuclear device.

Pakistan evened the score against India in a tunnel dug into the Ras Koh range in the Chagai region of desolate southwestern Baluchistan. Little effort was made to disguise Pakistan's preparations for the tests from satellite detection. Nonetheless, the statements issued after the five shots on 28 May were often confusing and contradictory. A. Q. Khan, an engineer regarded as the father of Pakistan's uranium enrichment program and the Ghauri missile, said that the yield of the largest of the five devices was 30 to 35 kt and that the others were of small, low-yield weapons ideal for battlefield use. But seismic data from IRIS suggest that the total yield was in the range of 8 to 15 kt, raising widespread suspicion that Pakistan exaggerated both the number and yield of the tests. Notwithstanding, Khan said at a news briefing on 30 May that the tests went "exactly as planned and were as good as we were hoping."

IRWIN GOODWIN

With Big Budget Increases Unlikely, OMB Head Scolds Scientists as Unhelpful

Despite the bipartisan support in Congress for science and technology funding increases in fiscal 1999 and the bonanza of scientific discoveries celebrated over the airwaves and in the headlines in recent months, most lawmakers now doubt that President Clinton's double-digit R&D requests will be passed this fall. In fact, except for such popular agencies as the National Institutes of Health and the National Science Foundation, the funding outlook for R&D is not much better than it was before Clinton's proposal. It turns out that science may be a victim of its own success. The pace of advances is so swift that not even many scientists can keep up with the fields, and Congress, which never had more than a handful of members who understood science, is beginning to argue that the nation's R&D may be moving too fast for its own good.



RAINES: 'More' is not the right answer.

Clinton's increases were neatly assembled in the $31 billion Research Fund for America (RFFA), which was designed to raise the Federal investment in nondefense R&D to $37.4 billion in 1999, a boost of $1.8 billion, or 5.1%. The plan would bolster Federal support for academic research to $14.5 billion, or 6.1% (PHYSICS TODAY, March, page 71).

But spending limits contained in last summer's agreement to balance the Federal budget, along with the declining likelihood that Congress will pass legislation providing for a tobacco settlement—which the White House had counted on yielding as much as $65 billion over five years in annual payments from cigarette manufacturers—make enactment of RFFA improbable. Indeed, the increases Clinton had urged Congress to appropriate would clearly exceed the spending limits of last year's Balanced Budget Act. Without the tobacco windfall, lifting the budget caps would require making use of the projected budget surplus, estimated at $39 billion this year by the White House and as much as $60 billion by the nonpartisan Congressional Budget Office. The catch in this is that the President has promised to apply the surplus to jack up the Social Security trust fund.

A few months before Clinton's budget request was sent to Capitol Hill, a bipartisan group of senators, led by Phil Gramm, a Texas Republican, introduced the National Investment Act of 1998 (S. 1035), which would authorize Congress to double the funding of all civilian science and precompetitive technology over the next ten years (see PHYSICS TODAY, December 1997, page 49). The proposed legislation was quickly backed by 103 science and engineering societies and more than 40 research universities.

The bill has been endorsed by 17 of the Senate's 100 members, but when it was discussed before the science, space and technology subcommittee of the Senate Commerce Committee, the measure was greeted with skepticism