

To Win NPT Extension, Nuclear States Promise Test Ban and Disarmament—Again

For the last quarter-century the nuclear Nonproliferation Treaty has stood as the primary vehicle for preventing the spread of nuclear weapons throughout the world. On 11 May, following four weeks of intense negotiations—and many more before that—the NPT was extended indefinitely at a UN conference.

Two companion documents were also adopted: one to strengthen the process for reviewing compliance with the treaty and the other a set of “principles and objectives for nonproliferation and disarmament.” These included a call for the completion of a nuclear test-ban accord in 1996 and the “early conclusion” of a cutoff on the production of fissionable material; in addition, those countries with nuclear weapons reiterated their promise, as given in the original treaty, to reduce their nuclear arms, “with the ultimate goal of eliminating those weapons.”

Several leading arms-control groups welcomed the decision. “I thought the outcome was quite good, especially the provisions for a more lively review process in the future,” said Jonathan Dean of the Union of Concerned Scientists, which had supported both 25-year and indefinite extensions of the treaty. Starting in 1997, annual preparatory meetings will now be held in each of the three years leading up to the traditional five-year review conference, providing more opportunities to scrutinize compliance with the treaty. “Of course much will depend on what the member states make of them,” Dean added.

Debate and compromise

Entered into force in 1970, the NPT was given an initial life span of 25 years. In the months leading up to the conference that would decide the treaty's fate, the US had campaigned hard for an indefinite and unconditional extension. In a speech at the Arms Control Association in Washington on 23 February, Under Secretary of State Strobe Talbott told his audience that the Clinton Administration was now in a “full court press.” But while only a handful of countries wanted the treaty dissolved, a much larger number seemed to favor a conditional extension; anything else, they reasoned, would greatly diminish the incentive for disarmament.

The Nonproliferation Treaty has nearly universal support, but can its lofty disarmament goals be reached?

Deliberations got underway on 17 April at the United Nations headquarters in New York City. Over the next four weeks various proposals were put forward, contested, modified and then withdrawn. Influential members of the Nonaligned Movement, which included more than 100 developing countries, called for rolling 25-year extensions linked to a disarmament timetable, an item intensely opposed by the US and its allies. A Mexican plan would have made the NPT permanent only if specific disarmament goals were met. In a compromise that ultimately prevailed, South Africa proposed an indefinite extension accompanied by—but not directly linked to—several confidence-building measures; these eventually became the documents on disarmament and the review process.

During the final week Arab countries circulated a resolution demanding that Israel accede to the NPT and open its nuclear facilities to international inspection; following heated last-minute negotiations, the resolution was sanitized into one supporting the creation of a nuclear-weapons-free zone in the Middle East but stripped of any mention of Israel. That statement was then adopted along with the treaty decision.

Is it working . . .

As stated in its preamble, the Treaty on the Non-Proliferation of Nuclear Weapons has four main purposes: to halt the spread of nuclear weapons, to make peaceful uses of nuclear technology widely available, to bring an end to the nuclear arms race and move toward total disarmament, and to seek a ban on nuclear bomb testing. The treaty restricted nuclear arms to those countries that already had them—the US, the UK, France, China and the Soviet Union. (Russia inherited the USSR's position in the NPT; most of the other FSU states have also signed the treaty.) All other countries pledged to neither develop nor acquire nuclear weapons; as

proof, they accepted safeguards on nuclear materials and facilities set down by the International Atomic Energy Agency (see the box on page 47). With 179 nations now party to the NPT, it is the most widely observed agreement on arms control.

Speaking before the UN on 18 April, German Foreign Minister Klaus Kinkel stated, “The treaty may not be perfect, but it has worked remarkably well over the past 25 years.” Has it? The evidence is mixed.

For example, South Africa succeeded in building several nuclear weapons but then chose to abandon its weapons program and joined the NPT in 1991. In an address during the conference Foreign Minister Alfred Nzo said that his country did so “because we saw our security being guaranteed by [the treaty's] provisions.” Beginning in the 1970s Argentina and Brazil also made moves to acquire nuclear arms. But in 1990 they too renounced their nuclear weapons ambitions, in part because, as an Argentinian official put it, “We found we were blacklisted by the international community for our aggressive policies.”

On the other hand there is Iraq, which following the Persian Gulf War was revealed to have a weapons program well under way, despite being a party to the treaty and under IAEA supervision. North Korea, another NPT signatory, is also suspected of accumulating bomb-making know-how and materials. Three other countries known or believed to have nuclear weapons, Israel, Pakistan and India, have refused to sign the treaty.

The fact that these countries felt compelled to pursue weapons points to a fundamental problem, some NPT critics say. “The whole idea of trying to deal with nuclear proliferation largely through denial of access to technology, expertise and critical materials is a temporizing and inadequate approach, on both political and technical grounds,” says George Rathjens of MIT, who helped develop the original treaty. “The NPT diverts attention from getting at the motivations that nations have to acquire weapons.” A more effective (though more costly) alternative, he believes, is through security guarantees like those the US provided to Japan, South

Technology May Help Contain the Nuclear Genie

Countries that sign the nuclear Non-proliferation Treaty commit themselves to making "safeguards" agreements with the International Atomic Energy Agency to facilitate information exchange and site inspections. The IAEA, which is an intergovernmental organization affiliated with the United Nations, currently keeps tabs on about 800 nuclear facilities in 60 or so countries, and in 1993 it conducted more than 2000 inspections for the purpose of "nuclear material accounting."

Since the IAEA's creation in 1957, and even since the NPT went into effect in 1970, great advances in communications and computing technology have contributed to the political transformation of the world. These capabilities may ease IAEA's watchdog burden, especially in its examination of the so-called declared nuclear facilities.

Remote monitoring

John Matter, a physicist who manages the cooperative monitoring systems department at Sandia National Laboratories, says that the most significant technological developments in materials monitoring have been the system integration of complementary sensors (that is, sensors that use different detection mechanisms and that monitor different types of activities) and the electronic transmission of the monitoring data, "which is just beginning to occur." The Department of Energy's Office of Nonproliferation and National Security has several international remote-monitoring evaluation projects under way, in collaboration with organizations in Australia, Japan, Argentina, Sweden and Germany.

DOE recently demonstrated remote monitoring of a storage vault at Argonne National Laboratory and a similar vault at the Kurchatov Institute, in Russia. (See the article by Frank von Hippel in *PHYSICS TODAY*, June, page 26.) The US monitoring

center, located at Sandia, and the Russian center, at the Kurchatov Institute, can each retrieve data from the instruments in the two vaults. Electronic seals on containers and switches on doors can also activate the system, as can motion sensors. After being triggered, video cameras (now analog, soon digital) capture images and relay them, via international telephone lines, to the other country. Satellite transmission is also possible, and monitoring may eventually occur via Internet. Although an occasional on-site presence will still be called for, such a system holds the potential to reduce greatly the need for frequent inspections, thus lowering expenses for both the IAEA and the host countries.

According to Ken Sheely, DOE's remote-monitoring manager, the IAEA recently made an official request for the US to conduct field trials of the remote-monitoring technology. The trials, still in the planning process, will probably occur at a light-water reactor in Switzerland and at Y12, at Oak Ridge National Laboratory.

In designing a system of this sort for full-scale international monitoring, several problems quickly arise. First, the equipment itself must be tamperproof. Then, at a minimum, stringent data authentication and encryption techniques are necessary. More than that, sophisticated data-analysis software will have to be developed to analyze the large amounts of digital information being transmitted. Ideally the computers receiving the data would flag nonstandard changes and other suspicious activities, which would probably be buried within legitimate operations that could be ignored.

Matter also said that real-time tracking of the movement of material from one site to another has become possible "from a technology point of view." In the US the

DOE tracks movement of special nuclear materials by its secure transportation system, and tracking systems can be assembled from commercial technology. Internationally, the development of commercial satellites and cheap signal reception from Global Positioning System satellites would allow tagged containers to be tracked and the information transmitted anywhere in the world.

Some try to hide

Covert operations represent a more dangerous problem, with solutions not easily amenable to international accords. As discussed in a report last month from the Office of Technology Assessment, the IAEA is not an intelligence agency, and unless it is given much greater access to the intelligence information of its member states, its resources for detecting undeclared facilities will remain limited. In a statement to this year's nonproliferation conference, Hans Blix, the director general of the IAEA, said that 61 countries "for which the NPT is in force" do not have the safeguards agreements that the treaty requires.

Environmental monitoring may be able to help here; samples taken from both inside and outside a facility can be analyzed for traces of escaped material that indicate nuclear activity. OTA's Alan Crane points out that this technique might be especially useful for detecting undeclared activities at declared sites. Crane says that the IAEA has decided to take a series of steps to implement environmental monitoring, which he called "potentially a very powerful adjunct to safeguards agreements."

In the end establishing compliance is a statistical problem. One cannot say with 100% certainty that a nation is not diverting material, only that it does not appear to be doing so.

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Korea and the NATO countries following World War II.

The US is now trying that approach with North Korea, which has been offered two new nuclear reactors to give up its weapons program. But it remains to be seen whether that agreement will stick—or if something similar could bring India, Pakistan and Israel into the treaty.

... Or not?

Disarmament, another NPT objective, has been progressing rapidly in recent years, with the US and Russia eliminating more than 2500 missiles and an entire class of weapons under the Intermediate-Range Nuclear Forces Treaty. The US is dismantling 2000 warheads each year. Still,

during most of the NPT's lifetime the two countries were pitted in an arms race that left behind huge nuclear arsenals; between the two, there are now more than twice as many long-range warheads as when the treaty went into effect—16 900 versus 7455—according to figures from the Natural Resources Defense Council.

Many of the non-nuclear countries that signed on to the NPT did so believing that they would gain greater access to nuclear energy technology, under article IV of the treaty. But as Nigerian Ambassador Tom Ikimi noted in a speech at the UN, "We cannot but reiterate our disappointment that while African countries have faithfully adhered to the treaty and concluded safeguards agreements with the IAEA, the

expected benefits have not been realized." That contention was recently underscored by the controversy surrounding Russia's sale of nuclear power plants to Iran. Fearing that Tehran would use them for destructive ends, the Clinton Administration condemned the agreement and imposed a trade embargo on Iran. But Iran countered that its compliance with the NPT entitled it to the Russians' help.

The flap over Iran gets at one of the most widely debated concerns about the NPT: By promising nuclear technology to all, does the treaty encourage the spread of the very thing it's trying to constrain? Nonproliferation groups such as the Nuclear Control Institute in Washington and the Wisconsin Project on Arms Control believe it does

and have argued convincingly that the treaty should be rethought on those grounds. But the NPT's newly permanent status may leave little room for such discussion.

Still awaited is the completion of a comprehensive test-ban treaty, something the five nuclear states have promised by the end of next year. Four already have test moratoriums in place; only China continues to test. On the Monday following the NPT extension, the People's Republic detonated its latest nuclear device, an odd punctuation to the UN talks.

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Boyce Passes AAS Executive Office to Milkey

On 10 August Robert W. Milkey will become the new executive officer of the American Astronomical Society. Milkey, currently associate director for program management at the Space Telescope Science Institute in Baltimore, replaces Peter B. Boyce, who has held the position since 1979. Boyce will move to a newly created position in the society. As senior associate, he will help to transform the society's journals and communications into electronic form and to revitalize public-policy programs by assisting AAS members in dealing with their Congressional representatives.

"The society's activities have expanded to the point where we need two full-time people with scientific backgrounds in the executive office in Washington," says Sidney Wolff of the National Optical Astronomy Observatory, who is a past president of

STAT OF THE MONTH

The members of the Acoustical Society of America are engaged in diverse areas of specialization. The adjacent table indicates the important areas of interest for ASA members. The total adds to more than 100%, as members were permitted to check up to three areas each.

%	Area of Interest
34	Noise and noise control
34	Physiological and psychological acoustics
32	Engineering acoustics
29	Speech communications
28	Underwater acoustics
25	Physical acoustics
19	Architectural acoustics
19	Structural acoustics and vibration
17	Musical acoustics
14	Signal processing in acoustics
12	Acoustical oceanography
9	Animal bioacoustics
4	Bioresponse to vibration and to ultrasound

Source: AIP Education and Employment Statistics Division (stats@aip.org).

AAS and the head of the search committee that selected Milkey. "We saw in Bob someone with very strong administrative experience, experience in managing budgets and also experience interacting effectively with funding agencies."

Milkey received both his master's degree (1967) and doctorate (1970) in astrophysics from Indiana University. After a one-year postdoctoral assignment, he joined the Kitt Peak National Observatory, in Tucson, Arizona. From 1971 to 1980 Milkey held a variety of positions at the observatory, from astronomer in the solar division to assistant director of administrative services.

Milkey left Kitt Peak to become the assistant director of the Institute of Astronomy at the University of Hawaii in Manoa. In 1982 he moved to the corporate headquarters of the Association of Universities for Research in Astronomy, where he served for two years as corporate staff scientist before becoming the associate director

for program management at STScI, one of the AURA institutes. Milkey says he made a career choice to put administration ahead of his own research: "I felt that I could do more for science and contribute more to the overall research output by enabling others to do research."

In his new position, Milkey says, "the very first thing is to educate myself about the operation of the society." Asked about his plans for the society, he replied: "It seems to me that it is working very well and I don't want to upset anything. There may be some embryonic ideas rolling around in my brain but I wouldn't want to expose them to the world at this point."

Looking back

The society that Milkey inherits is certainly different from the one Boyce took over in 1979. Then the society had 3500 members; now it has 6300. The 1979 budget was \$1.5 million; now it is \$6.4 million. "The officers of the society were ready for change," says Boyce of the expansions that began with a politically savvy move from the basement of the Princeton observatory to Washington, DC, just before he was hired. "I came along with a plan and a desire to play a more activist role."

Boyce, who had worked at the National Science Foundation and as a Department of Commerce Congressional Science and Technology fellow, started as executive officer with a five-point plan addressing areas of the society in need of improvement. Over the years Boyce and an office staff that grew from 3 to 11 improved communication between the society and its members via the AAS *Newsletter*, the *Job Register* and electronic media, and between the society and Congress through public-policy initiatives.

Says Milkey: "I can remember a fairly passive society before Peter ar-



ROBERT MILKEY



PETER BOYCE