OPINION

Scientific steps to nuclear disarmament

An advisory group and a network of international labs is needed to lay the groundwork for multilateral disarmament and forge links between nations, say **Martin Rees**, **Ben Koppelman** and **Neil Davison**.

SUMMARY

- Scientific collaboration has helped nuclear negotiations to date
- Researchers must now develop technology to support disarmament
- This requires a new international advisory group, and cooperating laboratories to study verification

Delegations from the 189 countries that have signed the 1968 Nuclear Non-Proliferation Treaty (NPT) are at the United Nations headquarters in New York this month for the treaty's five-yearly review. Their discussions are focused on the treaty's 'grand bargain', in which the five recognized nuclear-weapons states (China, France, Russia, the United Kingdom and the United States) agree to pursue negotiations towards nuclear disarmament, and those states without nuclear weapons agree to forgo acquiring or developing them. Nuclear-weapons states are now showing signs of taking their part of their bargain more seriously, to ensure the international cooperation necessary for tighter controls on nuclear technology, to resolve the cases of Iran and North Korea and to prevent further proliferation.

The scientific community must now help to develop the technology to support the process of disarmament, so that the technical groundwork is done when multilateral negotiations require it. Scientists have long played a crucial part in nuclear-arms control — for example, developing the technologies for detecting illicit underground testing of weapons.

> "Even at the height of the cold war, Russian and US scientists worked together on verification approaches."

We see two important ways to aid disarmament. First, a new international scientific advisory group should be set up to guide international cooperation on disarmament research. Second, a network of disarmament laboratories with international participation should be established. These labs could take forward the recommendations of the advisory group, and ensure that nations work together to create internationally acceptable solutions. The trust built through such international cooperation would also aid wider political negotiations. The scientific community's well-established international networks can reach into countries where political links are tense or weak, enabling collaboration even with those countries outside the NPT that have nuclear weapons (India, Israel and Pakistan).

Now is a good time to start these efforts. This treaty review, in contrast to others in recent years, has been preceded by serious and credible public debate about multilateral nuclear disarmament. A 2007 article in *The Wall Street Journal* by a 'gang of four' authors including former secretaries of state Henry Kissinger and George Shultz, called for the United States to take a leadership role in reversing global reliance on nuclear weapons. This catalysed discussion in many countries, culminating in US President Barack Obama's speech in Prague last year setting out a vision of a world free of nuclear weapons. Political challenges remain, including: questions between, and within, nuclear-weapons states about confidence in the verification of disarmament; the distrust between certain countries; and how to engage countries with nuclear weapons outside of the NPT.

The US–Russian bilateral Strategic Arms Reduction Treaty, renewed in Prague last month, limits the number of deployed nuclear warheads in these countries. This does not require mechanisms to verify that nuclear warheads are dismantled and eliminated. The same is unlikely to be true for future treaties. As the Russian and US nuclear-weapons stockpiles drop to sizes comparable to those of the other nuclear-weapons states, agreed verification mechanisms need to be ready, to maintain progress towards multilateral negotiations and reductions.

Two key challenges are building confidence and detecting cheating during the dismantlement process, especially when inspectors will need to authenticate the presence of genuine warheads. Passive detection of the spontaneous stream of γ-rays and neutrons emitted by the fissile material in nuclear weapons can be used to verify the presence of plutonium and determine its isotopic content (to tell whether it is weapons grade). Active methods — that detect radioactive signatures emitted after interrogating fissile material with radiation — may be more appropriate for verifying the presence of highly enriched uranium. The basic scientific understanding of these processes is well established. What is needed is a truly international approach to the design, testing and implementation of these techniques so that all stakeholders are confident in their use for disarmament verification. A central challenge is to develop 'information barrier' technologies. These confirm the presence of a nuclear warhead without disclosing sensitive details about its design, the revelation of which is prohibited under the NPT. Such details may also be classified by national laws.

Other areas for research include finding suitable and verifiable ways to dispose of fissile material, and developing ways to verify that a nation holds no clandestine nuclear weapons, material or facilities. Remote detection is a key area for further study.

Science without borders

As scientists around the world become more interested in solving these problems, they can look to the United Kingdom as a leader. In July 2009, the UK government laid out its strategy for the NPT review conference in its *The Road to 2010* document. This states that the country has "become a disarmament laboratory", pointing to the verification research programme at the Atomic Weapons Establishment (AWE) as a key player. Set up a decade ago, AWE has been collaborating with laboratories in Norway, helping each country to gain a better understanding of the transparency needs of a nuclear-weapon state and non-nuclear-weapon state.

More international disarmament laboratories in this vein should be founded. Such labs should also create partnerships between governments and the non-governmental community. The UK–Norway partnership is a powerful model: it has been assisted by the non-governmental Verification Research, Training and Information Centre (VERTIC) in London. This partnership has been developing prototype information-barrier technology to identify a radiological source (representing a warhead) to a specified level of confidence. It has also been developing a methodology for on-site inspections, to provide inspectors with carefully managed access to highly sensitive facilities.

Renewed interest in disarmament coincides

NORWEGIAN DEFENCE RESEARCH ESTABLISHMENT

Norwegian and UK researchers are testing verification techniques on mock nuclear weapons.

with discussions about the role of nuclear-weapons laboratories, including the US labs. As nuclear stockpiles shrink, the technical skills and specialized facilities of these labs will need to be maintained to certify the safety, security and reliability of the remaining weapons. Similar skills will be necessary to verify the disarmament process, as well as helping to prevent, detect and respond to acts of nuclear proliferation.

The best scientific minds and latest advances across government, industry and academia must be integrated into these efforts. For example, in 2007 the Royal Society organized a workshop on innovative methods to detect nuclear materials, which has since engendered several effective collaborations between AWE and academic departments. Collaboration needs to be interdisciplinary, drawing on the natural- and social-science communities, and other relevant communities, such as policy organizations and the military. This will ensure that technological solutions not only work but are politically viable.

To some, it may seem unrealistic to propose that scientists from countries between which political links are strained should collaborate on nuclear disarmament. However, there are precedents, including the global monitoring set up to verify compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT) once it formally comes into force. This system is based on the activities of a group of scientific experts, from more than 30 countries, in the development and testing of seismic monitoring of nuclear-test explosions from the mid-1970s to the early 1990s, despite a difficult political climate. Although scientists continue to improve this system's capabilities, the technical groundwork on verification was well established and internationally accepted by the time the CTBT came to the negotiating table in the mid-1990s.

Careful steps

Even at the height of the cold war, Russian and US scientists worked together on common verification approaches for nuclear-arms control, thanks in part to legal agreements, such as the Warhead Safety and Security Exchange Agreement, that clearly articulated the areas for collaboration. In contrast, in the late 1990s, scientists from Chinese and US nuclear-weapons labs began to collaborate on arms control without such a careful framework outlining the boundaries of discussion. That work broke down amid claims that sensitive information had been revealed.

> "Science can help to pave the road towards a world free of nuclear weapons."

The option of trilateral agreements, whether involving a nation or independent organisation as the third party, can also help to smooth talks between contentious political partners. The Trilateral Initiative of 1996–2002, for example, developed a system by which Russia and the United States could submit classified forms of fissile material from their nuclear weapons to the International Atomic Energy Agency for monitoring and verification.

There are also precedents for cooperation at the non-governmental level. In 1980, the US National Academy of Sciences established a Committee on International Security and Arms Control, and a counterpart committee was set up at the Soviet Academy of Sciences. Ongoing dialogue between these groups has been credited with helping to reduce tensions and for laying the groundwork for eventual dialogue between presidents Ronald Reagan and Mikhail Gorbachev. This sort of scientific cooperation can initiate and sustain dialogue that may not be possible at the governmental level, and can explore contentious issues that may impede official negotiations.

There have been calls for a high-level group of international experts to advise governments and develop a framework for cooperation on the scientific and technical aspects of nuclear disarmament. For example, in 2008, Jonas Gahr Støre, the Norwegian foreign minister, called for an Intergovernmental Panel on Nuclear Disarmament.

Given the political sensitivities around disarmament, an attractive alternative might be a non-governmental initiative, perhaps facilitated by national academies of science, to bring together relevant experts from all states with nuclear weapons. Relevant research has been carried out in many different countries but much of it is fragmented. This group could begin by reviewing what has already been done and identifying what gaps remain, to integrate efforts into a coherent research road map.

We hope that diplomats at the NPT review conference will support such a group, and commit to setting up and funding a network of collaborative and international disarmament laboratories to take forward its recommendations. This could pay significant dividends during discussions in New York and beyond, by providing concrete evidence that nuclear-weapons states are taking seriously their obligations to pursue disarmament. Although nuclear disarmament and non-proliferation remain politically sensitive, science diplomacy can help to pave the road towards a world free of nuclear weapons. ■

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