Resurrecting the Test-Ban Treaty

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President George W. Bush came into office opposed to the 1996 Comprehensive Test-Ban Treaty for nuclear weapons, and he has not sought Senate ratification during his seven years in the White House. Indeed, there were reports that, early in his administration, he was considering options for reversing the formal signature of the treaty by President Clinton in 1996. In the end Bush did nothing so drastic. But on top of his decision to withdraw from the 1972 Anti-Ballistic Missile (ABM) Treaty and minimise the binding nature of the 2002 Moscow Treaty on offensive strategic arms, his opposition to the test-ban treaty was seen as a serious blow to arms control.[1] As the Bush presidency winds down, those seeking to replace him must decide whether or not to push for ratification.

Critics and supporters of the treaty tend to agree that it is among the most important issues facing the country in the nuclear realm, just as Bush and Senator John Kerry agreed during the 2004 presidential election campaign that nuclear proliferation was the most important challenge facing the United States. But agreement stops there. The broader foreign-policy community has reached no bipartisan consensus on whether the treaty would serve American security interests. Given how controversial the treaty has been along partisan lines, and the fact that it requires a two-thirds Senate vote for approval, presidential candidates who support it will need to cam-

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paign on it if there is to be any hope of its eventual passage. Otherwise, the new president will have a hard time claiming the mandate needed to override strong political resistance to the treaty, or even start a serious Congressional debate.

In fact, while the debate over Bush's withdrawal from the ABM Treaty got the most press, his stance on the test-ban treaty may have been the most consequential. The ABM Treaty limited defensive arms, and generally non-nuclear ones at that. By contrast, the test-ban treaty focuses squarely on nuclear weapons themselves. The ABM Treaty was negotiated in the context of the specific dynamics of the Cold War superpower relationship. Although many have supported it more generally, it nonetheless arose from the desire of Washington and Moscow to prevent a US–Soviet offence–defence arms race. By contrast, the case for the test-ban treaty is less dependent on specific circumstances.

The treaty has been explicitly identified by many non-nuclear-weapons states as their top priority in recent years. More specifically, it is what they demand out of the established nuclear powers as a condition for their continued willingness to forgo nuclear weapons themselves, while also agreeing to place their civilian nuclear programmes under the additional protocol of the International Atomic Energy Agency (that provides for thorough inspections of facilities), and ideally also agreeing to obtain nuclear fuel for civilian reactors from an international fuel bank rather than their own enrichment or reprocessing capabilities. The indefinite extension of the Nuclear Non-Proliferation Treaty was achieved by the world community in 1995, according to the man who presided over the decision-making process, 'largely because the long-stalled comprehensive test ban … seemed at last certain of adoption'.[2] The test-ban treaty is thus directly linked to stopping nuclear proliferation. Even though it has been out of the headlines for several years, the continuing importance of the treaty is not easily exaggerated. With a US presidential campaign underway, and a new American president to be inaugurated fairly soon, the issue demands renewed attention and vigorous bipartisan debate.

Advocates of the treaty can at least be relieved about one thing: none of what Bush has done in regard to the treaty is irreversible. The president did not 'unsign' the treaty; he also has not tested nuclear weapons during his tenure in office and is unlikely to do so before leaving the White House.

His administration has periodically sought funds to research new types of nuclear warheads that would likely require testing somewhere down the road, yet these research efforts have been severely constrained by Congress. Whatever harm has resulted to the nuclear non-proliferation regime over the past seven years, notably the 2003 North Korean nuclear breakout and 2006 test, was probably not due primarily to American policy on nuclear testing. (During the pro-test-ban Clinton administration, India and Pakistan became de facto nuclear powers; the damage done to the global taboo on nuclear testing in the present decade is roughly comparable to that in the previous.) There is thus reason to think that the next American president might resume the push for a comprehensive ban on nuclear weapons testing, a goal of nuclear arms-control and non-proliferation advocates for half a century.

There are huge challenges to be addressed before any such agenda can be realised. At the US domestic political level, while it was Bush who wished to undo the treaty, it was the Republican Senate of the late 1990s that opposed its ratification. The Republican caucus voted almost unanimously against the treaty; opposition was hardly limited to the most conservative members. Many avowed internationalists, who have often supported treaties in the past and who value an American foreign policy that promotes multilateralism and the pursuit of international consensus on key issues, voted against the test-ban treaty. Former Republican secretaries of state George Schultz and Henry Kissinger are among those now favouring ratification, but the solid majority of Republican senators are on record in opposition.[3] They raised questions that will have to be answered if a future ratification vote is to gain the support of 10–15 Republican members, the minimum that will likely be needed to ensure its passage and to establish a strong bipartisan support for a ban on nuclear testing in the future.

Opposition was hardly limited to the most conservative members

The key questions about the treaty are these: can such a treaty be verified? Does it really help enhance the non-proliferation agenda, and if so, how? Does it allow the United States to ensure the long-term reliability of its existing arsenal in a manner that provides robust deterrence for the country and its allies? Finally, to the extent that might be judged necessary, is the treaty consistent with future American nuclear-weapons needs, such as the possible development of 'bunker buster' nuclear devices designed for deep underground detonation? All of these questions are serious. All have been considered before. But the standard answers given by test-ban advocates have not always been the strongest or most convincing. In addition, in some cases, the situation has changed in light of new geostrategic conditions and technical advances.

In pursuing ratification, treaty advocates will have to be extremely careful in how they handle the question of pursuing complete nuclear disarmament, a goal many of them (including Schultz and Kissinger) now favour. Nuclear abolition is an admirable objective, and research on how it might be achieved is laudable. But it is probably not achievable soon. Implying otherwise could hurt the prospects of what *is* achievable: ratification of the comprehensive test ban and related steps to lower nuclear danger such as further deep cuts in offensive arms and a fissile-material cut-off treaty. Many if not most test-ban treaty sceptics in the United States are worried that the treaty would weaken the American nuclear deterrent; they see this as a major liability of the treaty, not a strength. To be sure, if the treaty were to weaken America's nuclear deterrent, it *would* be a bad idea. Given the state of international politics, the world is probably not ready for nuclear abolition. Treaty sceptics must be reassured about the arsenal's robustness if there is to be any chance for ratification. They must not be led to fear that treaty ratification would be the first step towards a hasty pursuit of comprehensive denuclearisation. Treaty advocates therefore must be wary of conflating pursuit of ratification with near-term pursuit of a nuclear-abolition agenda. If they do, they could stoke the very worries of treaty critics that must be addressed and countered if this critical accord is to be ratified by the US Senate.

Is a treaty verifiable?

Large nuclear-weapons detonations are easy to detect. If in the atmosphere (in violation of the 1963 partial test-ban treaty) they are visible by satellite, and their characteristic radiation distribution makes them easy to identify. It is largely for such reasons that no country trying to keep its nuclear capabilities secret has tested in the atmosphere in the modern era. If the detonations are underground, as is more common, they are still straightforward to identify via seismic monitoring, provided they reach a certain size. Any weapon of kilotonne power or above (the Hiroshima and Nagasaki bombs were in the 10–20kt range) can be 'heard' in this way. In other words, any weapon with significant military potential tested at its full strength is very likely to be noticed. American seismic arrays are found throughout much of Eurasia's periphery, for example, and even tests elsewhere could generally be picked up. Indeed, though it either 'fizzled' or was designed to have a small yield in the first place, with a yield of about 1kt and thus well below those of the Hiroshima and Nagasaki bombs, the October 2006 North Korean test was detected and clearly identified as a nuclear burst.[4]

There are only two viable ways to escape detection. First, test a device well below its intended military yield, through some type of modification of the weapon's physics. (Doing this may in fact make the device very different from the actual class of weapon it is designed to represent, meaning that sophisticated extrapolation will be needed to deduce how the actual weapon would behave based on the results of the detonation of the modified device). Second, dig out a very large underground cavity into which a weapon can be placed, thereby 'decoupling' the blast from direct contact with the ground, and allowing it to weaken before it then reaches surrounding soil or rock and causes the Earth to shake. This latter approach is arduous. And it does not make a weapon totally undetectable, it simply changes the threshold yield at which it can be heard by American, Russian, and international seismic sensors.[5]

A country very sophisticated in nuclear technology might be able to conduct a test of a modified device that could escape international detection by virtue of having its normal yield reduced through modifications to the basic physics of the weapon. For example, less plutonium or highly enriched uranium – the main fissile materials that undergo chain reactions in any nuclear weapon and give fission bombs their main power – might be used. Or, if it was an advanced type of weapon (a 'boosted' weapon, whether a fission device or a thermonuclear bomb), less tritium might be used. But accomplishing such engineering feats would probably be beyond the means of a fledgling power. They are in fact difficult even for advanced nuclear powers. (This is much of the reason why the 1974 Threshold Test-Ban Treaty allows tests up to 150kt. It is hard to use very small explosions in the sub-kilotonne range to verify the proper functioning of a sophisticated and powerful nuclear weapon.) Scientists can learn some things from artificially small explosions caused by modified devices, but probably not enough to give them high confidence that the weapon they have developed is highly reliable.

US nuclear verification capabilities have picked up the Indian, Pakistani and North Korean nuclear tests (even the small, relatively unsuccessful ones) in the last decade and would be able to do so with high confidence for tests from those or other countries in the future. Verification capabilities are not airtight or perfect, but their limitations are on balance not grounds to oppose a comprehensive test ban.

Would the treaty help the non-proliferation agenda?

It cannot really be true, critics of the Comprehensive Test-Ban Treaty sometimes argue, that an end to US nuclear testing would stop proliferation, or testing by others. Surely Kim Jong Il of North Korea, or President Ahmadinejad of Iran, or even the leaders of Pakistan and India, are relatively unimpressed by any American nuclear restraint. The first two tyrants are not easily inspired by acts of moral courage by other states. India and Pakistan, for their part, tend to argue that a country like the United States with thousands of nuclear warheads in its inventory and almost a thousand nuclear tests under its belt is hardly in a position to deny others their nuclear rights. Any of these states, so goes the realist logic, will make nuclear-related decisions based much more on their own immediate security environments and agendas than out of concern for a global movement to limit the bomb's spread and lower its profile.

These are serious objections. They are probably correct to a large extent, at least for some overseas leaders much of the time. But they are not the end of the story or the argument.

While regional security conditions do matter more than global arguments for most countries contemplating the bomb, a strong international message against proliferation can still affect their calculations. If there is a sense that 'everyone is doing it', leaders teetering on the edge of going nuclear will feel less restraint about doing so, and perhaps even an obligation to protect their own countries from the potential nuclear weapons of their neighbours. In this regard, maintaining a strong international dissuasive force against nuclearisation is important, for it affects perceptions of the likelihood of proliferation. Indeed, efforts to delegitimise the bomb over the past half century, and efforts to reduce testing and reduce arsenals over the last four decades, have helped convince governments in places such as South Korea, Japan, Taiwan, Argentina, Chile, Brazil, Saudi Arabia, Egypt and Germany not to pursue these weapons. Sometimes treaty critics will trivialise these accomplishments, noting, for example, that it would not be so bad if a country like Japan or Brazil got the bomb. But such arguments, even if correct, ignore the fact that once the 'nuclear tipping point', is crossed and momentum grows for getting the bomb around the world, it will not be just the Japans and Brazils that go nuclear.[6]

Second, a comprehensive test-ban treaty would not physically prevent extremist states from getting the bomb, nor would it likely impress them with its moral force. But it would help reaffirm a norm, already acknowledged to a degree, that nuclear testing is unacceptable. This in turn will help discourage countries from testing the bomb out of fear that they will be punished if they do so. And if they test anyway, they will pay a price for it, which may convince them (or others) not to repeat the mistake.

This logic did not apply very well to the cases of India and Pakistan, which have not suffered serious reprisal from the world community as a result of their testing. As a generally stable and peaceful democracy, India's transgression was not viewed as anxiously as North Korea's by the international community. Pakistan's did raise major worries, but America's need to work with Islamabad in the struggle against extremists trumped the non-proliferation imperative in the short term.

However, the world reaction to North Korea's October 2006 test, including a UN Security Council Resolution limiting some types of world trade with North Korea, shows that this argument is valid. Norms do matter, because they help in pressuring violators. Until the test, China and South Korea had largely protected Pyongyang from severe sanctions, even after it broke out of the Non-Proliferaton Treaty in 2003. But when North Korea went so far as to test a bomb, Beijing, Seoul and Moscow told Pyongyang it had gone too far and agreed to economic reprisals against it. That appears to have helped force North Korea back to the negotiating table, contributing to the 13 Februrary 2007 accord that, while hardly a complete solution, may finally begin to arrest the North's nuclear programme.[7] It is also worth noting that Iran, for all of its efforts to develop nuclear technology, has shown some restraint to date, and tried to dress up its activities under the guise of peaceful nuclear activities. Testing is inconsistent with such pretenses, meaning that Iran will likely think twice about testing even if it someday produces enough fissile material to permit it. Or perhaps it will test just once, rather than five or ten times, making any resulting arsenal less reliable and quite possibly less sophisticated than it would otherwise be.

Norms do matter

This raises a broader point about testing. As far as we know, every country trying to validate a nuclear capability has succeeded on the first try. Simple fission bombs are relatively complicated devices, but generally not beyond the capacity of a country capable of enriching uranium or producing and reprocessing plutonium. However, developing advanced weapons — thermonuclear devices, devices capable of being delivered by missile, warheads capable of surviving atmospheric re-entry and still performing correctly — is hard. Several countries, including the United States, have had difficulties, needing multiple tests and corrective procedures before establishing confidence with a given warhead design. Making it hard for proliferators to test will make it harder for them to develop missile-mounted warheads of the type that would generally be most threatening to America and its allies.

A comprehensive test-ban treaty will not physically prevent testing, of course. But combined with a renewed effort to allow and even assist civilian nuclear-power programmes, likely to grow in appeal in coming years with rising oil prices and concerns about global warming, it can shore up the international consensus about which types of nuclear activities are acceptable and which are not. A treaty should probably be complemented by even stronger support for the Additional Protocol (to improve monitoring of civilian nuclear programmes so that they are not easily transformed into military programmes) and creation of an international uranium fuel bank for civilian reactors (to discourage development of enrichment and reprocessing capabilities by most states). This new nuclear deal can help re-create a strong international consensus on nuclear policy. It will then be more feasible to apply serious punitive measures to any state that violates the rules, ideally deterring behaviour such as nuclear testing in the first place.

Is a treaty consistent with stockpile reliability?

Most agree that the United States needs a nuclear deterrent well into the foreseeable future. Common sense would seem to support the position that, at some point at least, testing will be needed to ensure the arsenal's reliability. How can one go 10, 20, 50 or 100 years without a single test and still be confident that the country's nuclear weapons will work? Equally importantly, how can one be sure that other countries will be deterred by an American stockpile that at some point will be certified only by the experiments and tests of a generation of physicists long since retired or dead?

From the nuclear-arms-control point of view, of course, some of this perception about the declining reliability of nuclear weapons might be welcomed. Declining reliability might translate into declining likelihood of the weapons ever being used and declining legitimacy for retention of a nuclear arsenal. At least, that could someday be the hope. But as a practical strategic and political matter, any test ban must still allow the United States to ensure 100% confidence in its nuclear deterrent into the indefinite future.

This should be possible without testing. To be sure, with time the reliability of a given warhead class may decline as its components age. In a worst case, it is conceivable that one category of warheads might in fact become flawed without our knowing it; indeed, this has happened in the past. But through a combination of monitoring, testing and remanufacturing the individual components, conducting sophisticated experiments (short of actual nuclear detonations) on integrated devices, and perhaps introducing a new warhead type or two of extremely conservative design into the inventory, the overall dependability of the American nuclear deterrent can remain very good. In other words, there might be a slight reduction in the overall technical capacities of the arsenal, but still no question about its ability to exact a devastating response against anyone attacking the United States or its allies with nuclear or highly lethal biological weapons.

Consider first the issue of monitoring a given warhead type, and periodically replacing components as needed. This is the key way the United States is maintaining its nuclear arsenal at present (its last test was in 1992). As an example, a typical nuclear warhead has a shell of plutonium that is compressed by a synchronised detonation of conventional explosives that surround it. Making sure the explosion is synchronised along all parts of the conventional explosive, so that the compression of plutonium is symmetrical, is critical if the warhead is to work. Over time, wires can age, detonators can age, and so forth. But these types of components can be easily replaced and their proper functioning can be verified through simulations that make no use of nuclear material (and are thus allowable under the treaty).

Unfortunately it gets a bit more complicated than that once the compression of the plutonium is considered. The interaction of the conventional explosive with the plutonium is a complex physical phenomenon highly dependent on not just the basic nature of the materials involved, but their shapes and their surfaces and the chemical interactions that occur where they meet. Plutonium is not a static material; it is of course radioactive, and it ages in various ways with time. Conventional explosives age too, meaning that warhead performance can change with time. To prevent this, in theory one can rebuild the conventional explosives and the plutonium shells to original specifications every 20, 30 or 50 years, avoiding the whole issue of monitoring the ageing process by simply remanufacturing the key elements of the weapon every so often. In fact, one of the fathers of the hydrogen bomb, Richard Garwin, has recommended doing exactly that.[8] But others retort that previous processes used to cast plutonium and to manufacture chemical explosive have become outdated. For example, previous generations of plutonium shells (often called 'pits' in the nuclear trade) were machined to achieve their final dimensions, but this produced a great deal of waste. The goal for the future has been to cast plutonium pits directly into their final shape instead. Doing so, however, would create a different type of surface for the pit that might interact slightly differently with the conventional explosive, and even a slight difference might be enough to throw off the proper functioniong of a very sensitive, high-performance, low-error-tolerance warhead. Similarly, the way high explosives are manufactured typically changes with time. Replacing one type with another has in the past greatly affected warhead performance, even when that might not have been easily predicted based on the explosive force of the material; again, the detailed chemical interactions with the plutonium pit, among other such complex phenomena, are of critical importance.

So what to do? Garwin would argue that, for relatively small and shrinking nuclear arsenals, it is worth the modest economic cost and environmental risk (quite small by the standards of Cold War nuclear activities) to keep making plutonium pits and conventional explosives the original, outdated way. That would ensure reliability by keeping future warheads virtually identical to those of the past. But Garwin's argument is not presently carrying the day.

The US Department of Energy has instead devoted huge sums to its science-based Stockpile Stewardship Program, to understand as well as possible what happens within ageing warheads and to predict the performance of those warheads once modified with slightly different materials. It is a very good programme. But there is still an element of theory to this approach that will give some unease; for example, a key part of the effort is using elegant three-dimensional computer models to predict what will happen inside a warhead modified to use a new type (or amount) of chemical explosive based on computational physics. This method is good but perhaps not perfect, especially over the longer term.[9]

A final way to ensure confidence in the arsenal is to design a new type of warhead, or perhaps use an old design not currently represented in the active US nuclear arsenal but that has been tested before. This approach would seek to use 'conservative designs' that allow for slight errors in warhead performance and still produce a robust nuclear yield. This approach might lead to a somewhat heavier warhead (meaning the number that could be carried on a given missile or bomber would have to be reduced), or a lower-yield warhead (meaning that a hardened Russian missile silo might not be so easily destroyed, for example). But for the purposes of post-Cold War deterrence, this approach is generally sound, and weapons designers tend to agree that very reliable warheads can be produced if performance criteria are relaxed. It would also lead to less use of extremely toxic materials such as beryllium and safer types of conventional explosives (less prone to accidental detonation) than is the case for some warheads in the current arsenal.[10]

It is for such reasons that the Bush administration and Congress have shown interest in a 'reliable replacement warhead' concept in the last few years. It is still only a research concept, and a controversial one at that, with Congress not always willing to provide even research funding.[11] But it does have a certain logic and, as one element of a future American arsenal, makes sense on balance. In fact, designing warheads with extra margins of performance might even obviate the need to consider Garwin's idea, since it is quite clear that the United States could deploy such a warhead with extremely high confidence in its reliability.[12] Simple warhead designs are quite robust: the Hiroshima bomb (a gun-assembly uranium device) was not even tested before being used.

A future viable US nuclear arsenal might, for illustrative purposes, be made up of 500 reliable replacement warheads and another 500 carefully monitored versions of existing warheads.

Might there be new needs for nukes?

Some have suggested that a reason to preserve options for future nuclear testing lies in a potential need for new types of warheads to accomplish new missions. For example, in the 1980s, some missile-defence proponents were interested in a space-based nuclear-pumped X-ray laser. That was never particularly practical. But the idea of developing a nuclear weapon that could burrow underground *before* detonating has gained appeal, not least because countries such as North Korea and Iran are responding to America's increasingly precise conventional weaponry by hiding key weapons programmes well below the planet's surface.

One possible argument for such a warhead is to increase its overall destructive depth. In theory, the United States could modify the largest nuclear weapons in its stockpile to penetrate the ground. This approach would roughly double the destructive reach of the most powerful weapons in the current arsenal, according to physicist Michael Levi. But if an enemy can avoid weapons in the current arsenal, it could avoid the more powerful bombs by digging deeper underground. Given the quality of modern drilling equipment, that is not an onerous task.

Could Earth-penetrating weapons at least reduce the nuclear fallout from an explosion? They could not prevent fallout; given limits on the hardness of materials and other basic physics, no useful nuclear weapon could penetrate the Earth far enough to keep the radioactive effects of its blast entirely below ground. But such weapons could reduce fallout. As a rule of thumb, it is possible to reduce the yield of a weapon tenfold (or more) while converting it into an Earth penetrator while maintaining the same destructive capability against underground targets that a normal weapon would have.[13] This would reduce fallout by a factor of ten as well.

That would be a meaningful change. But is it really enough to change the basic usability of a nuclear device? Such a weapon would still produce a huge amount of fallout. Its use would still break the nuclear taboo. It would still only be capable of destroying underground targets if their locations were precisely known, in which case there is a good chance that conventional weapons or special forces could neutralise the target.

Use of such a weapon would still break the nuclear taboo

If such an Earth-penetrating weapon already existed, we might retain it for its marginal potential utility in a very rare class of possible scenarios. But the extremely limited set of circumstances for which it would have any utility at all means that it is hardly worth sacrificing a nuclear-testing moratorium, and the prospect of a comprehensive test ban, to develop such a capability. It is important to recall that, in the 1995 review of the Nuclear Non-Proliferation Treaty, ratification of the Comprehensive Test-Ban Treaty by the nuclear-weapons states was set forth by many non-nuclear states as a requirement if other countries were to sustain the tradition of non-proliferation.[14]

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The comprehensive test-ban treaty makes very good strategic sense for the United States and the world. The next American president should build on Bill Clinton's signing of that treaty, as well as George W. Bush's tacit compliance with its strictures, and send it to the US Senate for ratification. It makes sense whether Iran tests its own nuclear weapon in the coming years or not; either way, Washington will need more capacity to apply more pressure on states like Iran, and the treaty could help it garner international support for such pressure. American ratification of the treaty might also be part of a deal by which India and Pakistan agree not to do more testing themselves, joining the United States in a pledge of future nuclear-weapons restraint.

Notes

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