The Nuclear Test Ban: Technical Opportunities for the New Administration

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Despite what since has become a global norm against explosive nuclear testing, the CTBT itself does not enter into force until it is ratified by eight holdout states listed in Annex 2 of the treaty, including the United States. Even so, the accord is a well-established pillar of the international security system. The UN Security Council in September marked the treaty’s 20th anniversary by adopting Resolution 2310, which recognizes international support for the accord, reinforces the global norm against nuclear test explosions created by the treaty, underscores the value of the global monitoring system to verify treaty compliance, and calls on all remaining states to sign and ratify to facilitate its “early entry” into force.

Trump administration sets out policies on the CTBT regime and other nuclear arms control and nonproliferation issues, it should not overlook the opportunity to advance related scientific and technical measures to strengthen nuclear explosion monitoring worldwide.
The capability to detect nuclear tests has changed dramatically since 1999, when the Republican-controlled U.S. Senate voted against CTBT ratification, with opponents citing issues such as verification and a potential need for testing to maintain the reliability of U.S. nuclear weapons. At that time, there were no certified International Monitoring System (IMS) stations. At present, 285 of the planned 337 IMS stations are certified and monitoring the globe to detect and confirm any violations of the treaty. A 2012 National Academy of Sciences (NAS) study concluded that sensitive monitoring thresholds of IMS stations and national technical means would make it extremely difficult for even the most sophisticated states to evasively test nuclear weapons. The study also found that the U.S. nuclear stockpile stewardship program is maintaining a reliable arsenal under the 1992 U.S. moratorium on nuclear tests. These conditions have led numerous analysts to conclude that the treaty serves U.S. national security interests.

Even with persuasive technical capabilities in place and President Barack Obama’s April 2009 commitment to aggressively pursue U.S. ratification, his administration’s efforts were modest. They included outreach to senators, publication of Department of State factsheets, and participation of administration officials in nongovernmental events. Perhaps the lack of stronger action for ratification stemmed from political battles on Capitol Hill, including over the New Strategic Arms Reduction Treaty with Russia and the nuclear agreement with Iran.

Regardless, the case is clear for the Trump administration to redouble these efforts and pursue CTBT ratification. Yet, the incoming administration should not limit itself to seeking ratification. This article discusses a series of technical initiatives that would improve the already excellent global monitoring capabilities and further align the international community behind ending nuclear tests. Vote counting in the Senate should not cause stagnation or reduced U.S. support for these objectives. In fact, enhanced treaty-monitoring efforts would help further disprove CTBT critics and might stimulate global, bottom-up scientific pressures for ratification and entry into force.

**Improving Data Collection**

Worldwide detection of nuclear explosions requires expansive real-time monitoring and data processing that are unprecedented in the history of arms control. The NAS study expressed confidence in the capabilities of the IMS and other monitoring networks. The North Korean underground nuclear tests and Japan’s Fukushima Daiichi reactor crisis demonstrated the global effectiveness of the monitoring systems. Still, more work could be done to increase waveform and radionuclide data collection. Seismic, hydroacoustic, and infrasound waveform data are used to help identify the location of an event and to determine if it is natural or man-made. Radionuclide particulate and noble gas data can provide the “smoking gun” evidence confirming the occurrence of a nuclear explosion.

Steps to complete and expand the IMS will help to build greater international support for the treaty and conclusively confirm that states cannot carry out illicit nuclear tests without being caught.

**Completing the IMS.** The IMS is the backbone of the CTBT due to its critical role in collecting information about geophysical events. When complete, the IMS will consist of 50 primary and 120 auxiliary seismic, 11 hydroacoustic, 60 infrasound, and 80 radionuclide monitoring stations, as well as 16 radionuclide laboratories. Of these facilities, 285 are now certified, 17 are installed, 17 are under construction, and 18 are still in the planning process. Around the clock, they provide waveform, radionuclide particulate, and noble gas data, ensuring that states are not testing nuclear devices in the earth’s atmosphere, underwater, or underground.

The stations transmit real-time event data via satellite link to the International Data Centre (IDC) in Vienna, operated by the Comprehensive Test Ban Treaty Organization (CTBTO). Data center analysts make raw data and compiled event bulletins available to authorized users from CTBT states-parties.
Beyond the NAS study and a large body of scientific literature validating monitoring capabilities, the system has been successfully field-tested many times. Numerous IMS stations detected each of North Korea’s five underground nuclear tests. Within hours of North Korea’s most recent test on September 9, 2016, CTBTO Executive Secretary Lassina Zerbo announced, “So far 25 of our stations are contributing to the analysis.”

The utility of the IMS is not limited to nuclear explosion monitoring. For example, the gathered radionuclide data were essential for analysis of the radiation effects of the 2011 Fukushima Daiichi nuclear disaster. Furthermore, IMS data were instrumental in defining the mock area to be examined by on-site inspectors during the CTBTO’s successful field exercises in Kazakhstan in 2008 and Jordan in 2014.

The text of the accord has produced some unfortunate political difficulties alongside the many achievements of the monitoring network. Annex 1 to the treaty’s protocol specifies the national locations and coordinates for monitoring stations pursuant to the CTBT negotiations in the Conference on Disarmament. Like entry into force, amending the CTBT is a daunting task. At times, logistical and funding hurdles have delayed certification of IMS stations on small islands and in Antarctica. More troubling, however, is the presence of noncertified stations in states that have not yet ratified the treaty, such as China, Egypt, Iran, Pakistan, and Saudi Arabia. Although the Chinese stations are moving toward certification and transmitting data to the data center, other stations remain in political limbo.

As host to 38 certified IMS facilities on its various territories, the United States can credibly push for completion of the monitoring system. The United States could apply pressure or lend its technical capabilities to its Egyptian, Pakistani, and Saudi allies for installation and certification of these remaining stations. Additionally, Washington has diplomatic leverage when dealing bilaterally and multilaterally with other states slated to host IMS stations, including China, Ethiopia, Iran, and Thailand. If these stations came online, they would provide valuable monitoring data to the international community and trigger deepened engagement between the CTBTO and holdout states in their surrounding regions.

Concluding a Facility Agreement. The United States could also take a leading role in strengthening the IMS by concluding a facility agreement with the CTBTO. These agreements are intended to be signed between the organization and all 89 states that host IMS stations on their territory. Facility agreements cover matters such as IMS technical upgrades, station operator training, and the legal
aspects of CTBTO access to monitoring sites.

Only 45 of these 89 states have signed facility agreements, of which 38 such accords have entered into force.\footnote{11} Active facility agreements account for approximately half of the IMS stations. As the state hosting the greatest number of IMS stations, participation by the United States in the facility agreements regime is integral to the long-term success of the monitoring system. Leadership by the Trump administration would send a strong signal of the vital importance of unhindered and uninterrupted IMS data flow.

Breaking Ground on Cooperating National Facilities. Although adding new stations to the IMS is politically and legally difficult, the United States should promote the treaty’s often-overlooked Cooperating National Facility (CNF) provision. Under the CTBT, states are permitted to build facilities that make available supplementary data from national monitoring stations that are not formally part of the IMS. These facilities would be constructed at the expense of the hosting states-parties and require certification by the CTBTO just like treaty-designated stations.\footnote{12} Initial discussions on CNF data contributions to the IDC were similar to the protocols regarding IMS auxiliary seismic stations. That is, the stations would be operated by the hosting state with a satellite link allowing data flow to the IDC at the request of the CTBTO. In recent years, however, there has been debate in the CTBTO’s Working Group B on verification over whether the data center would be permitted to incorporate CNF data into its analyses.

CNFs would augment the strong monitoring capabilities of the IMS by offering new waveform and radionuclide data to the international community. Also, there are no limitations on the number of CNFs that states may build. Certified CNFs could help to attenuate the fears of states that are concerned about the activities of their neighbors and would be particularly useful in confidence building on verification for a future Middle Eastern nuclear-weapon-free zone. In 2000 a group of Israeli scientists published a study showing that national seismic network stations in Israel and Jordan could be certified as CNFs to enhance the precision of IMS location capabilities in the Middle East and eastern Mediterranean region.\footnote{13} Yet to date, no states have established such facilities, although several have expressed interest in developing “Prototype CNFs.”

The incoming administration should bring U.S. technical assistance to bear in support of U.S. allies and other states that are willing to host CNFs. These de facto IMS stations would expand monitoring coverage, which would be particularly valuable in regions where political difficulties have stymied completion of the IMS. By showcasing the importance of the data for their region, CNFs might also encourage reluctant host states to pursue installation and certification of treaty-mandated IMS stations. A key part of U.S. leadership on the CNF issue will be sustained diplomatic efforts to ensure that data collected by these facilities are distributed to all interested states-parties in compiled IDC data products and bulletins.

Expanding Data Analysis

If improving data collection is one side of the coin for more effective monitoring, expanding data analysis is the other. It is in the interest of U.S. national security to ensure that states around the world are making use of data from the IMS and future CNFs for verifying the absence of nuclear explosive testing. The CTBTO has made great strides toward this end under the leadership of Zerbo, the former head of the IDC. Alongside efforts to pursue treaty ratification, the United States should work with the CTBTO toward attaining universal use of these data among states-parties.

Increasing National Data Centers. Unlike the International Atomic Energy Agency’s high level of autonomy, the efficacy of the CTBTO, once the ban treaty enters into force, will be entirely dependent on its states-parties. Determining whether a treaty violation has occurred will not be left to international scientists and bureaucrats. Instead, ordering an on-site inspection will be a political decision requiring 30 affirmative votes from among the 51 state members of the CTBTO’s Executive Council. In principle, national votes will be made based on sound national scientific analyses.

For this reason, the establishment of national data centers is indispensable to the success of the CTBT monitoring and verification regime. Such centers are nationally designated institutes whose
responsibilities include sending IMS data to the IDC and receiving data and compiled data bulletins from the IDC. These national centers employ analysts with expertise in waveform and radionuclide technologies who evaluate data from the IMS and other national networks. Their objective is to determine whether nuclear explosions are occurring in regions of interest. These analyses will inform national responses to geophysical events, as well as votes on on-site inspections and treaty violations in the Executive Council.

The number of these national centers around the globe continues to expand, but these technical centers of expertise are far from universal. Of the 183 state signatories and 166 states that have ratified the treaty, only 129 have established such centers. Given the significance of Executive Council votes, it is clearly in the U.S. interest to ensure that political decisions are informed by rigorous scientific and technical analysis. The Trump administration should continue and expand on existing U.S. capacity-building programs while engaging in political outreach aimed at encouraging the development of these national centers.

**Broadening the Web Portal User Base.** Simply ensuring that states have access to raw IMS data and IDC data bulletins is perhaps even more important than establishing these national centers. Currently, access is available to authorized users affiliated with governments of state signatories. After entry into force, states will need to have ratified the treaty to maintain access for their authorized users. Data access takes place through a platform called the IDC Secure Web Portal. At present, 137 states have users accessing this platform. Although this array of states is impressive, they only represent three-quarters of states-parties with eligibility to access the data. To avoid misperceptions about potential nuclear tests, particularly in areas with pronounced regional tensions, the United States should encourage the use of the IDC Secure Web Portal. Washington should also support the development of the relevant technical expertise needed to analyze event data on this platform.

**Civil and Scientific Outreach**

Societies and civilian economies have long benefited from the peaceful uses of technology associated with global security. The IMS data are no exception. Article IV of the CTBT even notes that states-parties may “benefit from the application of [monitoring] technologies for peaceful purposes.”
vast. The treaty further states that satellite and electromagnetic pulse monitoring should be discussed as an expansion of the IMS. Accordingly, the United States should cooperate with the CTBTO to widen the promotion of civil and scientific uses of IMS data. This is particularly the case among countries that have not signed or ratified the treaty, pursued certification of their hosted IMS stations, or displayed notable interest in nuclear explosion monitoring.

**Interest in Explosion Monitoring.** The United States is but one of a few states in the world with CTBT monitoring and verification interests spanning the entire globe. Other states have more regionalized interests and will likely focus on “precision monitoring” directed at “one or a few countries of concern, or on limited areas of those countries.” Another group of states, however, are disinterested in nuclear explosion monitoring or believe that verification issues should be left to larger, more capable states. Involvement of these states in CTBT activities is important for dispelling the myth of the accord’s irrelevance and promoting Executive Council votes based on dispassionate scientific analyses.

The CTBTO recognizes that states have unequal levels of interest. Based on this understanding and the multifaceted utility of CTBT data, panels on civil and scientific uses of data have been a part of the organization’s biannual science and technology conferences since 2009. Some examples of alternative uses of data include hydroacoustic tracking of whale migration patterns and seismic hazard mapping of fault zones to protect populations from earthquakes.

IMS data have also been instrumental in mitigating the consequences of disasters. This was highlighted by the use of radionuclide data in the wake of the Fukushima Daiichi reactor crisis in 2011 and infrasound monitoring of the eruption of the Eyjafjallajökull volcano in Iceland a year earlier. After the devastating 2004 Indian Ocean tsunami, the CTBTO began to cooperate on real-time tsunami warning with the UN Educational, Scientific and Cultural Organization. Tsunami warning centers in 14 countries have signed agreements with the CTBTO to receive data from relevant IMS stations. In 2011, UN Secretary-General Ban Ki-moon recognized such achievements, stating, “Even before entering into force, the CTBT is saving lives.”

Specialists with the expertise to develop seismic hazard maps or radionuclide atmospheric transport models often have the ability to participate in CTBT monitoring and verification activities. Many national data center experts split their time between nuclear explosion monitoring and civil scientific pursuits. The United States should work alongside the CTBTO to continuously engage these experts. This should entail promoting the civil and scientific uses of IMS data, while encouraging technical experts to apply their skills to the domain of nuclear explosion monitoring. To be effective, such scientific partnerships require a broad understanding of the applications for CTBT-related data that states may find useful. Opening channels for cross-national data sharing and research may facilitate improved communication regarding potential nuclear tests.

U.S. promotion of the civil and scientific applications of IMS data may also increase global political ratification prospects for the CTBT. Such activities could emphasize the numerous benefits of treaty participation for those states that remain outside of the test ban regime. Another potential benefit might be a better understanding of the value of installing and certifying the remaining IMS stations.

**University and Industry Collaborators.** National data centers’ analysts and national monitoring experts are not the only people who could make use of the large repository of data associated with the CTBT regime. Many technical experts in academia and private industry have a professional interest in disaster response, geophysical hazard mitigation, nuclear explosion monitoring, and other related scientific endeavors. The CTBTO has recognized the necessity of incorporating these communities into its activities, as indicated by their increasing participation at the science and technology conferences. Due to limited IMS data access, however, universities and the private sector can only play a small role in leveraging CTBT technologies for the benefit of their countries and the international community. With growing interest in IMS data from domestic sectors outside of the U.S. government, Washington is well positioned to advocate for an increasingly open and transparent scientific culture surrounding the CTBT.

The CTBTO has opened its doors outside of official governmental channels through the creation of its Virtual Data Exploitation Center. This platform enables researchers working on scientific projects to
request access to IMS data. If the CTBTO approves, researchers are granted access to archival, event-specific data that is not useful for monitoring and may not be published in its raw form.

This platform and other initiatives are an encouraging start to furthering IMS data transparency. Still, the United States should consider supporting greater levels of openness. Perhaps the states-parties would allow the CTBTO to open its data repositories to universities and the private sector after a certain amount of time. With this lag, the data would be of no use in sensitive, real-time nuclear explosion monitoring activities. Yet, these archived waveform and radionuclide data would be useful for such undertakings as earthquake preparedness, meteorological tracer studies, and iceberg mapping. Further, accentuating the scientific benefits would increase pressure on CTBT holdout governments to reconsider the utility of the accord for their population.

**Entry Into Force Prospects**

This article has highlighted a number of technical initiatives the incoming Trump administration should pursue alongside CTBT ratification. Proponents of the treaty have a persuasive technical and national security case for ratification. Given this and the precedent that U.S. ratification would set for other Annex 2 states, the administration will surely face domestic and international ratification pressures. As the new administration considers a ratification debate, it should not forget about the complementarity of science, technology, and politics within the CTBT sphere.

Efforts to increase the flow of CTBT-related data and expand and train the community that analyzes these data would strengthen the administration’s hand against treaty critics. In the 1999 debate over the CTBT, prominent critics such as Senator Jon Kyl (R-Ariz.) argued that the treaty was unverifiable. Senator John McCain (R.-Ariz.), who will likely play an outsized role in a ratification debate, noted in 2008 that he was willing to revisit the issue of CTBT verifiability. Times and verification prospects have changed drastically since 1999. The near-completion of the IMS, success of the stockpile stewardship program, and publication of the decisive NAS study on CTBT verification should leave no lingering doubts among even the treaty’s past detractors. The scientific and technical initiatives described above will only further discredit skeptics of the CTBT at home and abroad.

Still, the Trump administration must not restrict its focus to attaining U.S. ratification of the test ban. Seven other Annex 2 states have yet to ratify the treaty: signatories China, Egypt, Iran, and Israel and nonsignatories India, North Korea, and Pakistan. Although those who have signed remain obligated to the accord under the Vienna Convention on the Law of Treaties, their ratification is required for entry into force and activation of the treaty’s mechanism for on-site inspections.

Top-down U.S. political and diplomatic outreach efforts to encourage other states to ratify the CTBT and complete the IMS should continue. Because of the pivotal role of technology in monitoring and verification, the United States should undertake an expanded international program of complementary bottom-up scientific outreach. Increased access to data and analytical training are integral to familiarizing experts with the CTBT and nuclear explosion monitoring, the IMS and its data, the civil and scientific benefits of the treaty, the CTBTO as an institution, and the global norm against nuclear tests.

When political decision-makers consult scientists about the utility and verifiability of the CTBT or about its Executive Council votes on on-site inspections or treaty violations, it is unmistakably in the U.S. national interest for these experts to be prepared to let the science speak for itself. Scientific outreach was one of the key components underlying effective U.S.-Soviet and U.S.-Russian arms control during the Cold War and beyond.

Now, the incoming administration has an opportunity to embrace scientific diplomacy, which may be the key to getting the dominoes to fall toward entry into force of the CTBT. This would truly be a remarkable foreign policy achievement by the Trump administration to strengthen global security.

**ENDNOTES**


2. States listed in Annex 2 to the CTBT are the 44 that participated in the negotiation of the treaty and had nuclear power or research reactors at the time. Their ratification is required before the treaty can enter into force. The eight remaining Annex 2 holdouts are China, Egypt, India, Iran, Israel, North Korea, Pakistan, and the United States. See CTBTO, “Comprehensive Nuclear-Test-Ban Treaty,” Annex 2.


6. CTBTO, “International Monitoring System.”

7. Prior to the CTBT’s entry into force, states-parties are defined as those states that have signed the treaty. After entry into force, states-parties will be those that have ratified the accord.


15. CTBTO, email correspondence with author.
16. Ibid.

17. Dahlman et al., Detect and Deter, p. 2.


19. CTBTO, email correspondence with author.


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