The 2012 National Academy of Sciences Report on Technical Issues Related to the CTBT

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In March 2012 the National Research Council of the National Academies published a Report, "The Comprehensive Nuclear Test Ban Treaty, Technical Issues for the United States," prepared by a study committee chaired by Prof. Ellen D. Williams of the University of Maryland.[1]. The Committee was composed of experienced academic, military, and national laboratory experts, including a former Director of the Lawrence Livermore National Laboratory—one of the two U.S. nuclear weapon explosive design laboratories. Its work was greatly aided by a Subcommittee on Seismology chaired by Prof. Lynn R. Sykes of Columbia University. The public report was supplemented by a classified version, which was identical in its conclusions and recommendations but provided additional details both on the question of nuclear weapons themselves and the utility of nuclear tests, and on monitoring and verification capabilities. Although the Report's scope was limited to technical issues, not policy, some of its conclusions are directly relevant to policy, for instance, whether the United States would need to return to nuclear explosion testing for any foreseeable reason.

As for monitoring and verification of compliance with the CTBT, the Report explores in detail the capability of the International Monitoring System of the CTBTO to monitor nuclear explosions underground, using seismic, radionuclide, and infrasound detection systems; underwater, using hydroacoustic and seismic systems; and in the atmosphere, using infrasound and radionuclide detection.

In addition, the Report considers the augmentation of the International Monitoring System by U.S. and open networks, extending to much more numerous seismic stations, all reporting now with high-quality digital data. In addition, a nuclear explosion within the atmosphere would be monitored by optical and electromagnetic pulse (EMP) sensors; any explosions in space are monitored by U.S. national technical means, including the detection

[1] http://www.nap.edu/catalog.php?record_id=12849

of EMP, optical flash, and nuclear radiation. Since a 2002 report by The National Academies, monitoring has improved substantially in view of the completion of the majority of the IMS, the addition of xenon radionuclide detection capability, the implementation of regional seismic detection and identification, the advent of broader bandwidth, digital seismic stations and arrays, and the increases in computing power and terabyte data storage.

As a result, the Report states that threshold levels of IMS seismic detection are now well below one kiloton worldwide for fully coupled explosions and, in particular, "in Asia, Europe and North Africa, the IMS detection thresholds are substantially better, at 0.09 to 0.22 kt depending on the regional geology."

An important part of the Treaty is on-site inspection, for which the Committee judges "A CTBTO on-site inspection (OSI) would have a high likelihood of detecting evidence of a nuclear explosion of yield greater than about 0.1 kilotons, provided that the event could be located with sufficient precision in advance and that the OSI was conducted without hindrance."

In general, the Report indicates that technical issues regarding detection and monitoring have largely been solved, and "the Committee has not been able to identify a potential threat that could arise through undetected nuclear-explosion testing that would require the U.S. to return to nuclear-explosion testing."

Beyond the work reported in The National Academies Report, I am optimistic about further improvements in the detection of nuclear explosions, which I have identified in a couple of presentations posted last month on my website at www.fas.org/RLG/. These include the more general use of "smart arrays" for regional seismic detection, which further reduce the detection threshold by a factor three to ten. Furthermore, there are potential improvements in the quality and likely reductions in cost of the fundamental seismometer instrument, by the use of optical seismometers. And, my third but by no means final impression is that a substantially new capability can be added if not to the IMS in the near future, at least to the world's detection capability by the observation at many ground stations of signals from the Global Positioning System and the European and Russian equivalents of GPS. An underground explosion disturbs the ionosphere, and proper sensing of GPS signals from many satellites at many ground stations can provide a sensitive indication and even location of an underground explosion.

The benefits of the CTBT will only be realized with ratification and entry into force, as a potent contributor to the effectiveness of the Nonproliferation Treaty itself. Although the United States, for instance, has been abiding by a self-imposed moratorium on nuclear explosion tests since 1992 and was one of the first to sign in 1996, it has not yet ratified the CTBT. Without entry into force there is substantial concern that other states will

modify their nuclear weaponry to the point that a nuclear explosion test would be demanded by powerful elements within that state. Given such a test, and the national and international capabilities for detecting it, there would be major pressure on even the five formal nuclear weapon states to conduct nuclear explosive tests (except for France, which has destroyed its test site in the Pacific). And in preparation for this eventuality there would likely be in these and other states, weapon systems "on the shelf" waiting for the opportunity of a nuclear explosion test. I believe that entry into force of the CTBT would substantially change that dynamic, since a nuclear test by a Treaty participant sould require the formal withdrawal from the Treaty, with six months notice and the inclusion of "a statement of the extraordinary event or events which a State Party regards as jeopardizing its supreme interests." As exemplified by the unfortunate withdrawal of the United States from the 1972 ABM Treaty, a CTBT would not be an absolute bar to the resumption of nuclear testing, but it would substantially increase the barrier and by removing the legal right of the five Nuclear Weapon States to conduct underground nuclear explosive tests, it would make membership in the NPT much more equitable than it is at present.

My participation in the U.S. National Academies study provides a technical basis for my judgment that it is in the U.S. national interest to join in ratification of the CTBT.