CTBT Verification Regime: Preparations and Requirements

Wang JUN

On 10 September 1996, six weeks after the last nuclear test explosion of the declared nuclear-weapon states (NWS), the 51st United Nations General Assembly voted 158–3 to adopt the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Two weeks later, over 130 states, including the NWS, signed the Treaty, breathing life into the "longest sought and hardest negotiated" international legal instrument prohibiting all nuclear test explosions in all environments for all time, regardless of yield and with no differentiation between the declared nuclear "have's" and "have not's". These historic events marked the beginning of a new era when the international society is governed by a norm that bans all nuclear test explosions. Months later, the Preparatory Commission for the CTBT Organization started functioning in Vienna. As of 9 July, there are 152 signatories and 38 ratifiers (including France and the United Kingdom, two of the NWS) and the numbers are growing.

All this may sound too good to be true judging from the stalemates found in multilateral disarmament efforts and the hurdles of the not-so-long-ago Cold War. Indeed, the CTBT would have been an impossibility had there not been the final demise of the East-West military confrontation that relied on mutual assured destruction to prevent escalation of conflict. The competitive game of the day was the ongoing perfection and regeneration of the "art" of nuclear weapons. That game is now over. Following forty years of strenuous disarmament efforts and with the changes in the global political climate, all the necessary precursors for the comprehensive test ban were in place.

Significance of the Treaty

What can be discerned as the specific significance of the CTBT? Based on some years of involvement in multilateral disarmament and direct experience with the entire CTBT negotiation process, the author has the following to offer:

- The CTBT came about against the backdrop of real nuclear weapon reduction, exemplified by the actual implementation of START I (1991), as well as the prospect of deeper nuclear weapon cuts under START II (1997) and further reductions. By capping the qualitative development of nuclear weapon programmes and introducing an effective global verification regime, the CTBT shall be instrumental for the process of general and complete nuclear disarmament.

Wang Jun is Chief of the Documentation Section, On-Site Inspection Division in the Preparatory Commission of the Comprehensive Nuclear-Test-Ban Treaty Organization.

- The CTBT completed the final and comprehensive check on all nuclear test explosions, overtaking previous instruments such as the Partial Test-Ban Treaty (PTBT, 1963), the Threshold Test-Ban Treaty (TTBT, 1974), and the Peaceful Nuclear Explosions Treaty (1976), as well as enhanced the existing nuclear non-proliferation regime.
- The CTBT succeeded in getting all declared NWS and threshold states on board the negotiation process. Though the two recent nuclear testers have yet to sign the CTBT, the fact that they, together with all five NWS, participated in the full negotiations is in itself unprecedented, as compared with the NPT, PTBT or TTBT. By establishing a new international norm of banning all nuclear test explosions, the CTBT will be the paramount instrument for the two states to join if they decide to make an official and permanent obligation to ban any further tests.
- The CTBT also achieved many "firsts":
  - — The first treaty negotiated with the participation of almost all countries with nuclear capability and signed by all five NWS. The forty-four nuclear-capable states are required to sign and ratify in order to bring the CTBT into force;
  - — The first multilateral nuclear disarmament and non-proliferation treaty equipped with an independent remote monitoring system specially designed for compliance verification, the International Monitoring System (IMS); and
  - — The first regime of global, short notice on-site inspections (OSIs) that incorporates an over-flight element, in addition to other technologies (geophysical and radionuclides) for nuclear test signature search.

As noted in its preamble, the CTBT provides a universal and multilaterally and effectively verifiable nuclear test-ban regime, which would contribute "to the prevention of the proliferation of nuclear weapons in all its aspects, to the process of nuclear disarmament and therefore to the enhancement of international peace and security." Simply put, the CTBT sees no more tests, no new nuclear weapons and no more new NWS in the world.

On the other hand, a truthful understanding of the CTBT's scope and its verification regime shows that despite all the political significance, the Treaty provides a precise and legal definition of coverage, namely, the banning of nuclear test explosions and any other nuclear explosion (including de facto banning of peaceful nuclear explosions) and not the prohibition of nuclear weapons per se. Those who favour general and complete nuclear disarmament might see this as a limitation. However, a stronger argument would be that this Treaty, the highest achievable objective given the current prevailing international reality, represents a major step toward the ultimate goal of nuclear disarmament. This is because the cessation of all nuclear test explosions will effectively constrain the development and qualitative improvement of nuclear weapons. In other words, the development of new, advanced types of nuclear weapons can be stopped. It would be hard to contemplate leeway for the furtherance of new nuclear knowledge and technology within the framework of a nuclear weapon ban. A nuclear weapon ban has to be based on a test ban.

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Building up the Verification System

A global remote monitoring network, the IMS, will be set up — as required by the Treaty for its verification regime. The IMS will consist of 321 remote sensing stations. This system employs four technologies (seismic, radionuclide, infrasound and hydroacoustic) proven to be effective for the detection and location of nuclear test explosions conducted underground, in the atmosphere or underwater.

All signal data collected from these stations will be fed to an International Data Centre (IDC), situated in the headquarters of the Organization (the CTBTO), and the data and processed products shall be provided to all states parties in the form of bulletins. Through this arrangement, states parties with different technological capabilities will enjoy equal access to the huge global monitoring database — data quantity will reach 10 gigabytes per day once the network is completed. Based on these data and supplemented with information obtained through national technical means, states parties will be able to analyze certain ambiguous events and then decide if they wish to request further measures, such as an OSI. This is a perfect form of mutual monitoring and assurance, the core concept for verifiable treaty compliance.

Soon after the commencement of the Preparatory Commission, the IMS was under construction. Over two years have elapsed and the construction is progressing well and is basically on schedule. To date, fifty primary seismic stations have been established — almost all existed prior to the conclusion of the Treaty, the requisite site surveys for about one-fifth of the total will be accomplished within the year; of 120 auxiliary seismic stations, over three-fourth are now standing; almost all site surveys for the total of eleven hydroacoustic stations will be completed in 1999; and one-fifth of the total sixty infrasound stations, mostly non-existent prior to the Treaty, will pass the stage of site survey within the year.

For the IDC, progress is even more impressive. The computer hardware installation is by and large finished and with the introduction and upgrading of relevant system software, the IDC has already acquired its initial capability of data analysis. The IDC is already collecting data from three of the four technologies of the IMS. In the short period from July to November last year, the IDC was able to detect and locate with much accuracy over 1,000 seismic events globally. It is safe to predict that with the gradual build-up of the IMS stations and corresponding calibration activities, the IDC and the IMS will acquire event detection and location capability far better than the theoretical design threshold of 1,000 ton yield for underground events.

To date, the Provisional Technical Secretariat of the CTBTO Preparatory Commission, which started work on 17 March 1997 and employs a staff of more than 180, has implemented a budget of over US$100 million. Over half of the total has gone into capital investment of the verification infrastructure. At this pace and input, the establishment of the CTBTO verification infrastructure, particularly the IMS and the IDC, can be achieved in a few years. The gradual commencement of these verification components will be a realistic and physical process irrespective of the legal constraints that may come with the entry into force of the CTBT.

Another important verification component of the Treaty is OSI. The basic parameters for this intrusive and last resort activity are that upon the request of states parties and subject to the Executive Council's approval, an inspection team will be dispatched by the CTBTO Technical Secretariat within six days to the site (which may be as large as 1,000 km^2) where an ambiguous event had been detected. The inspection activities, proceeding from the lesser to the more intrusive according to the exact phases of operation, range from overflight observation, ground surface survey, seismic aftershock detection and location, other geophysical measurement techniques, radionuclide measurements (including noble gas detection), to the final stage of drilling into the suspected underground detonation point. The sole purpose of the inspection is to collect technical findings for the determination of the true nature of the event. The telltale evidence is the radionuclide products unique to nuclear explosions. A maximum of forty inspectors and assistants may participate in these undertakings — except the drilling activities, which may require more people. The maximum duration for the entire inspection is 130 days.

Given that the most probable environment for suspected underground or subsurface nuclear test explosions would be in uninhabited areas and that the inspection activities themselves are technically varied and challenging, one prerequisite for the future OSI regime would be a readily available contingent of able-bodied and competent inspectors and their assistants.

Training of Inspectors

For the future CTBTO to acquire its full team of inspectors, training will be essential. One specific situation with regard to the Treaty's OSI regime is that there will not be a permanent inspectorate residing with the future Technical Secretariat, as is the case with the International Atomic Energy Agency (IAEA) or the Organisation for the Prohibition of Chemical Weapons. This is determined by the fact that all foreseeable OSIs would be rare events, on short notice and not of a routine nature. In addition, these inspections require highly specialized expertise mostly coming from national institutions. Only a large enough pool of specially designated inspectors, all qualified through training, can ensure the actual availability of inspectors on-call. If the required inspector cadres are two teams of forty persons each and the safe margin of required redundancy is five to one, the inspector roster size may well be around 400 persons. Then comes the question: how many trainees would have to pass the training programmes in order to acquire the sizeable roster? And yet, all this has to be achieved against the rare supply of able-bodied specialists for nuclear and other Treaty-permitted technologies for OSI. Just imagine how few people are there in the world who have actually had personal experience with nuclear test explosions and with sufficient first-hand knowledge of nuclear explosion related phenomenon and signatures and are therefore fit for the job.

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With all these difficulties in mind, and guided by the Preparatory Commission for the CTBTO, the Provisional Technical Secretariat has already developed training programmes and started introductory training courses, taking into consideration the following factors:

- technical mix and composition of an inspection team (see Table 1);
- rotational mode of operation of inspection team members, with the composition of the team to be adjusted to the different phases of inspection and the Treaty-permitted technologies;
- permanent back-up team capability and two simultaneous OSI missions requirements;
- highly diversified disciplines of expertise and special skills required of inspectors and inspection assistants;
- mandatory qualification for general training, such as Treaty and Protocol familiarization, OSI Operational Manual, policies and procedures, communication techniques, safety, code of conduct and administrative arrangements;
- specialized training required for specific inspection technologies, equipment operation, sample collection and handling, data analysis and processing, report drafting;
- cross-discipline training;
- "refresher" training for maintaining the constant readiness of inspectors; and

Table 1. Indicative Expertise Requirement for OSI

Activities (Drilling not included)	Goals	Techniques	Professions	Personnel
Position finding from the air	Confirm boundaries of the inspection area	Overflight equipment for location	Pilots/Navigators	2
Same at the surface	Same	Ground location equipment	Experts in ground position finding	2
Visual observation from air	Search for anomalies and/or artefacts	Video cameras, hand-held still cameras	Photographer, experts in nuclear test pheno-menology and signatures	2
Gamma-monitoring from the air	Search for radiation anomalies	Multi-spectral gamma-detectors	Radiation monitoring experts	2
Gamma-survey at the surface	Search for and identify radiation anomalies	Gamma-detectors, including energy resolution techniques	Same	3
Magnetic measure-ments from air	Search for magnetic anomalies	Equipment for magnetic field mapping	Magnetic field mapping experts	2
Same at the surface	Same	Same	Same	2
Multi-spectral imagery from the air	Search for heat and other anomalies	Infrared (night vision) devices	Experts in multispectral measurements	2
Same at the surface	Same	Same	Same	3
Environmental sampling at the surface	Detect radioactive anomalies	Equipment for sampling from above, at and below the surface	Experts in radioactivity sampling	4
Passive seismological monitoring	Search for aftershocks to localize inspection area	Low frequency seismometers	Seismologists	7
Resonance seismometry	Search for and localize cavities and rubble zones	Seismic sensors and sources	Seismologists	5
Electrical conduc-tivity measurement	Detect anomalies and artefacts	Electrical sensors and sources	Electrical engineers	2
Radar measurements	Detect underground anomalies	Ground penetrating radar device	Geophysicists	2
Total				40

Different phases of OSI do not require all the listed experts to be in the field, but there will be other inspection team members, covering administrative and logistic activities.

- varied forms of training, such as conventional classroom teaching, hands-on learning, tabletop or field exercises, and mock inspections.

Other Inspection-Related Training

CTBTO inspection-related training is not limited to inspectors and inspection assistants. The target groups also have to include national authority personnel of states parties, potential national escort team members, and certain policy-making governmental officials and experts. During 1998, the Provisional Technical Secretariat commenced the first OSI Introductory Course in Vienna within the framework of the overall Training and Exercise Programme. Based on the successful experience, two more introductory courses and one tabletop exercise will be conducted in 1999.

The CTBTO Preparatory Commission is a new international organization and the process of building up its full training capacity will be a long and challenging one. However, there seems no other way but to forge ahead, since without qualified inspectors with adequate training, the verification regime would lose credibility and all the significance described at the opening of this article may be compromised.