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Abstract

President Obama's administration has ushered in a banner period for nuclear issues, and the Comprehensive Nuclear Test-Ban Treaty ("CTBT") has figured prominently among them. In his benchmark April 2009 speech in Prague calling for the elimination of nuclear weapons, President Obama added that his administration would "immediately and aggressively" pursue US ratification of the treaty. In September, President Obama presided over the United Nations ("UN") Security Council summit meeting that adopted Resolution 1887, which "enshrines our shared commitment to the goal of a world without nuclear weapons" and also calls on states to "refrain from conducting a nuclear test explosion and to sign and ratify the CTBT, thereby bringing the treaty into force at an early date . . . ."

NONPROLIFERATION VERIFICATION AND THE NUCLEAR TEST BAN TREATY

Jenifer Mackby *

INTRODUCTION

President Obama's administration has ushered in a banner period for nuclear issues, and the Comprehensive Nuclear Test-Ban Treaty ("CTBT") has figured prominently among them. In his benchmark April 2009 speech in Prague calling for the elimination of nuclear weapons, President Obama added that his administration would "immediately and aggressively" pursue US ratification of the treaty.[1] In September, President Obama presided over the United Nations ("UN") Security Council summit meeting that adopted Resolution 1887, which "enshrines our shared commitment to the goal of a world without nuclear weapons"[2] and also calls on states to "refrain from conducting a

* Jenifer Mackby served as secretary of the negotiations on the Comprehensive Nuclear Test-Ban Treaty and the Group of Scientific Experts in Geneva as well as secretary of the Working Group on Verification at the CTBT Organization Preparatory Commission in Vienna. This Essay is based on a book she is co-authoring on the verification of the CTBT to be published by Springer in 2011.

1. *See* Barack H. Obama, U.S. President, Remarks in Prague, Czech Republic (Apr. 5, 2009).

2. *See* Barack H. Obama, U.S. President, Remarks at the United Nations [UN] Security Council Summit on Nonproliferation and Nuclear Disarmament in New York City, U.S. (Sept. 24, 2009).

nuclear test explosion and to sign and ratify the CTBT, thereby bringing the treaty into force at an early date . . . ."[3]

This was followed in April 2010 by a new Nuclear Posture Review, which is the first to refer to the elimination of nuclear weapons and which also states that "[r]atification of the CTBT is central to leading other nuclear weapons states toward a world of diminished reliance on nuclear weapons, reduced nuclear competition, and eventual disarmament."[4] An unprecedented gathering of world leaders at the Nuclear Security Summit in Washington, DC, in April 2010 was followed by the signing of the Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms ("New START") by President Obama and Russian President Medvedev.[5] Shortly thereafter, states parties of the Nuclear Nonproliferation Treaty ("NPT") adopted a final document at the May 2010 Review Conference that called on all states to "refrain from any action that would defeat the object and purpose of the Comprehensive Nuclear Test-Ban Treaty pending its entry into force, in particular with regard to the development of new types of nuclear weapons."[6]

Beginning with the proposal by Indian Prime Minister Jawaharlal Nehru in 1954 to the UN General Assembly, numerous generations have chased the elusive goal of a treaty banning nuclear explosive testing. Experts believe that a ban on nuclear explosions will curtail the capabilities of states parties to develop more advanced nuclear weapons and prevent an aspiring nuclear state from proving its capability.[7] It would thus impede a nuclear arms race and is seen as a measure to strengthen the NPT, which calls for nuclear disarmament in its Article VI, as will be discussed below.

The achievement of a test-ban treaty has run into obstacles each time it has been considered since 1958, particularly regarding verification issues. Another less apparent obstacle has

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3. S.C. Res. 1887, ¶ 7, U.N. Doc. S/RES/1887 (Sept. 24, 2009).

4. U.S. DEP'T OF DEF., NUCLEAR POSTURE REVIEW REPORT 13 (2010).

5. *See generally* Tom Z. Collina, *New START Signed; Senate Battle Looms*, ARMS CONTROL TODAY, May 2010, at 38.

6. 2010 Conference of the Parties to the Treaty on the Nonproliferation of Nuclear Weapons, New York, U.S., May 3–28, 2010, ¶ 83, U.N. Doc. NPT/CONF.2010/50 (Vol. I) (June 18, 2010) [hereinafter 2010 NPT Review Conference].

7. *See generally* COUNCIL ON FOREIGN RELATIONS, INDEPENDENT TASK FORCE REPORT NO. 62: U.S. NUCLEAR WEAPONS POLICY (2009).

been the international political situation. For example, in 1979, with the completion of Strategic Arms Limitation Talks II ("SALT II"), experts thought that a test-ban treaty was the next logical step, and there were high expectations that one would be negotiated.[8] However, a new atmosphere of tension surrounding the Soviet intervention in Afghanistan put both agreements on the back burner.

Almost forty years after the proposal by Prime Minister Nehru, in August 1993 countries in the Conference on Disarmament ("CD") in Geneva decided to negotiate a test-ban treaty. The mandate noted:

> The Conference on Disarmament,
>
> Taking note of initiatives regarding the negotiation of a comprehensive nuclear test ban treaty (CTB),
>
> Convinced that, to contribute effectively 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, a CTB should be universal and internationally and effectively verifiable . . . .
>
> [I]n order to achieve this goal, it is important that a CTB be multilaterally negotiated.[9]

The United Nations General Assembly adopted the CTBT in September 1996 by a vote of 158 to 3 (Bhutan, India, and Libya), with five abstentions (Cuba, Lebanon, Mauritius, Syria, and Tanzania).[10] As of November 2010, the CTBT claims 182 signatures and 153 ratifications.[11] States that have ratified have effectively signaled that the verification of the treaty suffices for them. The ratifying countries include three of the permanent members of the Security Council ("P5") (France in 1998, the

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8. *See, e.g.*, Henry Trofimenko, *SALT II: A Fair Bargain*, BULL. ATOMIC SCIENTISTS, June 1979, at 30.

9. *See* Conference on Disarmament, *Decision on Agenda Item 1 "Nuclear Test Ban" Adopted by the Conference on Disarmament*, U.N. Doc. CD/1212 (Aug. 10, 1993) [hereinafter *Decision on Agenda Item 1*].

10. *Voting Record for Comprehensive Nuclear Test Ban Treaty Ratification (A/RES/50/245)*, UNBISNET, http://unbisnet.un.org:8080/ipac20/ipac.jsp?profile=voting&index=.VM&term=ares50245 (last visited Apr. 4, 2010).

11. *Status of Signature and Ratification of the CTBT*, CTBTO PREPARATORY COMM., http://www.ctbto.org/the-treaty/status-of-signature-and-ratification (last visited Apr. 4, 2011) [hereinafter *CTBT Signatories*].

Russian Federation in 2000, and the United Kingdom in 1998), all members of the European Union, all US allies (NATO as well as Australia, Japan, and South Korea), and 82 of the 118 members of the Non-Aligned Movement.[12] Of the 114 signatories to the five nuclear-weapon free zone ("NWFZ") treaties (Bangkok, Pelindaba, Rarotonga, Semipalatinsk, and Tlatelolco),[13] all but seven have signed the CTBT.[14]

Yet in order to enter into force, the treaty requires ratification by the forty-four countries that were members of the Conference on Disarmament and possessed nuclear power and

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12. *Id.*

13. There are five regional NWFZs established by treaty. The provisions of each zone vary; however, each treaty at a minimum prohibit the stationing, testing, use, and development of nuclear weapons inside a particular geographical region: the Central Asia Nuclear Weapon Free Zone ("CANWFZ") Treaty (Treaty of Semipalatinsk), Sept. 8, 2006, *available at* cns.miis.edu/inventory/pdfs/aptcanwz.pdf (entered into force 2009) that includes Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan; the African Nuclear Weapon Free Zone Treaty (Treaty of Pelindaba), Apr. 11, 1996, 35 I.L.M. 698 (entered into force 2009); the Treaty on the Southeast Asian Nuclear-Weapon-Free-Zone Treaty (Treaty of Bangkok), Dec. 15, 1995, 1981 U.N.T.S. 129 (entered into force 1996); the South Pacific Nuclear Free Zone Treaty (Treaty of Rarotonga), Aug. 6, 1985, 1445 U.N.T.S. 177 (entered into force 1986), which differs from Tlatelolco in that it includes a ban on nuclear explosions and explosive devises for peaceful purposes, and prohibits its members from dumping nuclear waste into the zone's waters; and the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Treaty of Tlatelolco), Feb. 14, 1967, 22 U.S.T. 762, 634 U.N.T.S. 281 (entered into force 1968). All existing zones include provisions on full-scope safeguards. The CANWFZ Treaty is the first of the NWFZ treaties that requires each party to conclude the International Atomic Energy Agency (IAEA) Additional Protocol no later than eighteen months after the entry into force of the NWFZ treaty and to comply with the provisions of the CTBT. Establishing a NWFZ in the Middle East has been a priority of the Non-Aligned Movement ("NAM") for many years and was, along with the conclusion of the CTBT negotiations, included in the 1995 decision on the indefinite extension of the NPT. Each of the regional NWFZ treaties includes a protocol to be signed by nuclear-weapon states providing negative security assurances and respect for the NWFZs.

14. The seven signatories who have yet to ratify the CTBT are Cuba, Dominica, Mauritius, Niue, Somalia, Tonga, and Tuvalu. *See ANWFZ (Pelindaba Treaty) Membership*, JAMES MARTIN CTR. FOR NONPROLIFERATION STUD. (Dec. 17, 2010), http://cns.miis.edu/inventory/pdfs/apmanwfz.pdf; *CANFZ (Semipalatinsk Treaty) Membership*, JAMES MARTIN CTR. FOR NONPROLIFERATION STUD. (Feb. 17, 2009), http://cns.miis.edu/inventory/pdfs/apmcanwz.pdf; *SEANWFZ (Bangkok Treaty) Membership*, JAMES MARTIN CTR. FOR NONPROLIFERATION STUD. (May 28, 2009), http://cns.miis.edu/inventory/pdfs/apmseanwfz.pdf; *SPNFZ (Rarotonga Treaty) Membership*, JAMES MARTIN CTR. FOR NONPROLIFERATION STUD. (Mar. 18, 2008), http://cns.miis.edu/inventory/pdfs/apmspnwfz.pdf.

research reactors in 1996.[15] Slightly less than one-fifth of those countries have not ratified, and thus entry into force of the treaty has been delayed. These countries include China, the Democratic People's Republic of Korea ("DPRK"), Egypt, India, Indonesia, Iran, Israel, Pakistan, and the United States.[16]

The United States triggered the negotiations in 1993 at the Conference on Disarmament and galvanized the international community to complete the negotiations, which then became part of the decision relating to the 1995 NPT Review and Extension Conference.[17] The United States was the first to sign the treaty in 1996.[18] However, in 1999 by a vote of fifty-one to forty-eight, the US Senate did not provide its advice and consent to ratification (sixty-seven are needed).[19] Before analyzing the arguments in the United States and elsewhere for and against the treaty, it is worthwhile to examine the precursors to the treaty.

I. *PREVIOUS EFFORTS*

A number of attempts were made over the years to codify a prohibition of nuclear testing; however, the first tangible inclusion in international law occurred when the Soviet Union, the United Kingdom, and the United States pledged to negotiate the cessation of nuclear test explosions in the Treaty Banning Nuclear Weapon Tests in the Atmosphere, Outer Space and Under Water, known as the Partial (or Limited) Test Ban Treaty ("PTBT") of 1963.[20] At that time the negotiators were not able to achieve a comprehensive test ban because of a disagreement about verification: the Soviet Union contended that national

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15. Comprehensive Nuclear Test Ban Treaty art. XIV, ¶ 1, Sept. 24, 1996, S. Treaty Doc. No. 105-28 (1997), 35 I.L.M. 1439 [hereinafter CTBT]. See Annex II of CTBT for a full list of parties required to ratify prior to the treaty entering into force.

16. *See CTBT Signatories*, *supra* note 11.

17. 1995 Review and Extension Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, New York, U.S., Apr. 17–May 12, 1995, *Decision 2: Principles and Objectives for Nuclear Non-Proliferation and Disarmament*, U.N. Doc. NPT/CONF.1995/32 (Part I) (May 11, 1995) [hereinafter 1995 Review and Extension Conference].

18. *See CTBT Signatories*, *supra* note 11.

19. *See* Craig Cerniello, *Senate Rejects Comprehensive Test Ban Treaty; Clinton Vows to Continue Moratorium*, ARMS CONTROL TODAY, Sept./Oct. 1999, at 26.

20. *See generally* Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, Aug. 5, 1963, 14 U.S.T. 1313, 480 U.N.T.S. 43 [hereinafter PTBT].

technical means of detection and identification would suffice for verification, while the United States insisted that on-site inspections would also need to be included. Recognizing that they did not complete the objective they had set, negotiators settled on inserting in the preamble of the PTBT the following words, followed by the first article:

> Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end, and desiring to put an end to the contamination of man's environment by radioactive substances,
>
> Have agreed as follows:
>
> Article I
>
> 1. Each of the Parties to this Treaty undertakes to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or any other nuclear explosion, at any place under its jurisdiction or control:
>
> (a) in the atmosphere; beyond its limits, including outer space; or under water, including territorial waters or high seas; or
>
> (b) in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted. It is understood in this connection that the provisions of this subparagraph are without prejudice to the conclusion of a Treaty resulting in the permanent banning of all nuclear test explosions [emphasis added], including all such explosions underground, the conclusion of which, as the Parties have stated in the Preamble to this Treaty, they seek to achieve.
>
> 2. Each of the Parties to this Treaty undertakes furthermore to refrain from causing, encouraging, or in any way participating in, the carrying out of any nuclear weapon test explosion, or any other nuclear explosion, anywhere which would take place in any of the environments described, or have the effect referred to, in paragraph 1 of this Article.[21]

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21. *Id.* art. 1.

It is worth noting the first article of this treaty because the CTBT would, thirty-three years later, derive its basic obligations from it. Article 1 of the CTBT is almost identical, though obviously it does not include subparagraphs 1 (a) and (b). The PTBT contained no provisions for verification, relying mostly on national technical means. It did not provide any definition of nuclear weapon test explosion; the same omission in the CTBT has become an issue among opponents of the treaty. Neither of the above presented significant obstacles for the PTBT, which was considered important in large part because it ended the era of above-ground testing, though it did not prohibit underground testing. On the other hand, the PTBT never obtained the signature of France or China, two of the five recognized nuclear-weapon states ("NWS").[22]

During the intervening years between the two negotiations, numerous initiatives called for a test-ban treaty, including one to simply amend the PTBT so that it would become a complete ban on nuclear testing in all environments. This led to an amendment conference in 1991 to extend the PTBT to cover underground testing, which would have transformed the PTBT into a test-ban treaty. However, this initiative was unsuccessful.[23] While the PTBT helped reduce radioactive contamination and imposed some limitations on testing, it did not stop the qualitative advances in nuclear weapons. Thus the international community eventually called for new negotiations in 1993.

The CTBT has a long-standing connection to the Nuclear Nonproliferation Treaty, the cornerstone of the nonproliferation regime and the most widely adhered to arms control treaty, with 189 states parties.[24] The preamble of the NPT refers directly to a test ban:

> Recalling the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble

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22. *See Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water*, U.S. DEP'T OF STATE, http://www.state.gov/t/isn/4797.htm#signatory (last visited Apr. 4, 2011).

23. *See 'More Work' Needed to Amend Partial Test-Ban Treaty*, U.N. CHRON., June 1991, at 30.

24. *See Status of the Nuclear Nonproliferation Treaty*, U.N. OFFICE OF DISARMAMENT AFF., http://unhq-appspub-01.un.org/UNODA/TreatyStatus.nsf (click "NPT" hyperlink in left-side frame) (last visited Apr. 4, 2011).

> to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end . . . .[25]

Further, Article VI states, "Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control."[26] In the Review Conferences and other meetings associated with the NPT, non-nuclear states raise the CTBT as the first priority of Article VI. This harks back to the negotiations of the NPT, when a number of non-nuclear countries proposed specific provisions that they wanted to include in Article VI, such as the discontinuance of all test explosions of nuclear weapons, a cutoff of the production of fissionable materials, and a freeze on the manufacture of nuclear weapons, among others.[27] The United States and the Soviet Union preferred a simple treaty without linking it to other measures, which they thought would hinder the conclusion of the NPT and not lead to agreement on other measures. They thus wanted to undertake to pursue negotiations in good faith because, as the US negotiator stated, "it is obviously impossible to predict the exact nature and results of such negotiations."[28] In addition, some US allies, such as Canada and Australia, noted that it was not reasonable to ask the nuclear-weapon states to pledge to hard measures when neither China nor France were participating in the NPT negotiations.[29]

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25. Treaty on the Non-Proliferation of Nuclear Weapons pmbl., July 1, 1968, 21 U.S.T. 483, 729 U.N.T.S. 161 [hereinafter NPT].

26. *Id.* art. VI.

27. For a full discussion of the negotiations on Article VI of the treaty see 2 MOHAMED I. SHEKER, THE NUCLEAR NON-PROLIFERATION TREATY: ORIGIN AND IMPLEMENTATION, 1959–1979, at 555–648 (1980).

28. Zia Mian, *The American Problem: The United States and Noncompliance in the World of Arms Control and Nonproliferation, in* INTERNATIONAL LAW AND ORGANIZATION: CLOSING THE COMPLIANCE GAP 266–67 (Edward C. Luck & Michael W. Doyle eds., 2004).

29. *See* U.N. GOAR, 22d Sess., 1573d mtg. ¶ 25, U.N. Doc. A/C.1/PV.1573 (May 23, 1968); U.N. GOAR, 22d Sess., 1570th mtg. at 17, U.N. Doc. A/C.1/PV.1570 (May 17, 1968); U.N. GOAR, 22d Sess., 1557th mtg. ¶ 14, U.N. Doc. A/C.1/PV.1557 (Apr. 30, 1968).

This lack of specificity in Article VI has been interpreted in different ways by the NWS, which contended at the NPT Review Conferences that they are taking steps towards nuclear disarmament, and by the non-nuclear weapon states ("NNWS"), which accuse the NWS of not living up to their obligations and consequently hold an underlying resentment. During the first Review Conference of the NPT in 1975, Sweden proposed immediate negotiations directed towards a treaty banning all underground nuclear-weapon test explosions as a measure to halt the nuclear arms race.[30] A group of twenty NNWS, led by Mexico, proposed a protocol to the NPT in which the three depositary governments would lead in a multilateral treaty banning all nuclear-weapon testing.[31]

At the 1990 NPT Review Conference, the lack of progress on a test-ban treaty was one of the reasons for the inability to achieve a consensus on a final document. In 1995, the CTBT was linked to the decision to extend the NPT indefinitely. The decision to extend the NPT included a set of principles and objectives for nuclear nonproliferation and disarmament. One of these was the conclusion of the negotiation of a test-ban treaty no later than 1996, as there was no guarantee at the time that negotiations would soon wrap up. At the 2000 Review Conference, the early entry into force of the CTBT was the first of a list of thirteen steps for the implementation of Article VI that were agreed upon in the final document of the conference.[32] The fact that the treaty has not entered into force is stated to be one of the factors that led the non-aligned states to voice frustration over certain states not meeting their Article VI obligations.

The lack of entry into force of the CTBT has also been cited as a reason the 2005 NPT Review Conference did not adopt a

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30. *See* Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, Geneva, Switz., *Working Paper Submitted by Sweden on Article VI*, U.N. Doc. NPT/CONF/C.I/8, *in* U.N. Doc. NPT/CONF/35/II (May 30, 1975).

31. *See* Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, Geneva, Switz., *Final Document*, Annex II, arts. 3, 5, U.N. Doc. NPT/CONF/35/I (May 30, 1975).

32. *See* 2000 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, New York, U.S., Apr. 24–May 19, 2000, *Final Document*, at 14, U.N. Doc. NPT/CONF.2000/28 (Part I) (2000).

final document.[33] While the treaty still has not entered into force, the final document of the 2010 NPT Review Conference stated that all NWS should "undertake to ratify the [CTBT] with all expediency," noting that this would encourage other states to do the same.[34] The final document also said that the NWS should encourage the Annex Two countries (the remaining nine of the forty-four ratifications required for the treaty to enter into force) in particular to ratify.[35]

On a bilateral basis, the treaty between the United States and the Soviet Union on the limitation of underground nuclear weapons tests, known as the Threshold Test Ban Treaty ("TTBT"), was signed in 1974 and entered into force in 1990.[36] The TTBT prohibits testing warheads having a yield exceeding 150 kilotons (equivalent to 150,000 tons of TNT), thus establishing a nuclear "threshold."[37] The preamble and first article also hark back to a ban on nuclear testing as expressed in the PTBT:

> Recalling the determination expressed by the Parties to the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and to continue negotiations to this end,
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> Noting that the adoption of measures for the further limitation of underground nuclear weapon tests would contribute to the achievement of these objectives and would meet the interests of strengthening peace and the further relaxation of international tension,
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> . . .

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33. *See* Harald Müller, *The 2005 NPT Review Conference: Reasons and Consequences of Failure and Options for Repair*, THE WEAPONS OF MASS DESTRUCTION COMMSSION (Aug. 2005), http://www.blixassociates.com/wp-content/uploads/2011/03/No31.pdf.

34. *See* 2010 NPT Review Conference, *supra* note 6, at 23.

35. *See id.*; *see also* Wolfgang Jans & Kiyoshi Suyehiro, *Hydroacoustics*, *in* SCIENCE FOR SECURITY: VERIFYING THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY intro. (2009).

36. Treaty on the Limitation of Underground Nuclear Weapon Tests, U.S.-U.S.S.R., July 3, 1974, 1714 U.N.T.S. 216 [hereinafter Threshold Test Ban Treaty].

37. *See id.* art. I; *see also Threshold Test Ban Treaty*, U.S. DEP'T OF STATE, http://www.state.gov/t/isn/5204.htm (last visited Apr. 4, 2011).

> Article I
>
> 1. Each Party undertakes to prohibit, to prevent, and not to carry out any underground nuclear weapon test having a yield exceeding 150 kilotons at any place under its jurisdiction or control, beginning March 31, 1976.
>
> 2. Each Party shall limit the number of its underground nuclear weapon tests to a minimum.
>
> 3. The Parties shall continue their negotiations with a view toward achieving a solution to the problem of the cessation of all underground nuclear weapon tests.[38]

Other treaties, such as the recently concluded New START treaty, recognize the commitments to the obligations contained in NPT Article VI, although they do not specify the actions that might satisfy those obligations.[39]

II. *VERIFICATION OF THE CTBT*

The CTBT prohibits states parties from carrying out any nuclear weapon test explosion or any other nuclear explosion in any place under their jurisdiction or control. The verification system of the CTBT is designed to provide a high level of confidence that clandestine nuclear explosions will be detected by the international community. States wanted the treaty to include extensive verification provisions in order to be "universal and internationally and effectively verifiable," as stipulated in the mandate given the negotiators in 1993.[40] The resulting provisions for verification are unprecedented, with 337 stations and laboratories in over ninety countries around the world.[41] This International Monitoring System ("IMS") employs four integrated technologies, with three waveform techniques—

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38. *See* Threshold Test Ban Treaty, *supra* note 36, pmbl., art. I (footnote omitted); *see also* PTBT, *supra* note 19 and accompanying text.

39. Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms pmbl., U.S.-Russ., Apr. 8, 2010, U.S. DEP'T OF STATE, http://www.state.gov/documents/organization/140035.pdf [hereinafter New START Treaty].

40. *See Decision on Agenda Item 1*, *supra* note 9, pmbl.

41. *See* Ola Dahlman et al., *Cheaters Beware*, BULL. ATOMIC SCIENTISTS, Jan./Feb. 2002, at 30; *CTBT: Ending Nuclear Explosions*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/fileadmin/user_upload/public_information/CTBT_Ending_Nuclear_Explosions_web.pdf (last visited Apr. 4, 2011).

seismic, hydroacoustic, infrasound—and two radionuclide techniques for the detection of radioactive gases and particles.[42]

The seismic system includes fifty primary and 120 auxiliary land-based seismic stations distributed around the world to detect underground nuclear explosions, down to low yields.[43] The basis for this seismic network derived from the Group of Scientific Experts, which started working in 1976 under the CD on seismic verification issues for a test-ban treaty. There experts from around the world examined these issues throughout the Cold War and carried out a number of technical tests on an international network. This network formed the core of the seismic monitoring system that became part of the treaty during the negotiations from 1994 to 1996. The primary stations provide continuous data, while the auxiliary stations respond upon request for additional data. Many of the primary stations are arrays, with sensors arranged over an area to provide information on the direction and the speed of the incoming signal. There are not many arrays outside of the IMS, and the radionuclide, hydroacoustic, and infrasound networks are unique. All IMS stations must be certified according to agreed specifications.[44]

The IMS calls for eleven hydroacoustic stations that monitor possible explosions in the ocean.[45] Events in the ocean can be detected relatively easily because of the Sound Fixing and Ranging ("SOFAR") channel, which can pick up sounds from thousands of kilometers away. For example, in 2008, about forty-four pounds of TNT were detonated off the coast of Japan and the signal was detected by sensors off the coast of Chile, more than 3700 miles away.[46]

Five of the hydroacoustic stations, called T-phase stations, are located on islands and are designed to register acoustic signals that travel in water but convert to seismic signals when they hit steep coastlines.[47] Due to the ease of transmission of

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42. *See* Dahlman et al., *supra* note 41, at 30.

43. *See id.* at 32; *see also CTBT: Ending Nuclear Explosions*, *supra* note 41, at 2.

44. *Glossary*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/glossary(last visited Apr. 4, 2011).

45. *See CTBT: Ending Nuclear Explosions*, *supra* note 41, at 2.

46. *See* Jans & Suyehiro, *supra* note 35, at 19.

47. *See* Dahlman et al., *supra* note 41, at 33; *Hydroacoustic Monitoring*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/verification-regime/monitoring-

signals in the oceans and the sensitivity of the hydroacoustic stations, roughly two-thirds of the planet can be monitored with only eleven stations.[48] So far, all but one of these stations has been certified to meet the specifications delineated by the CTBT Preparatory Commission.

Infrasound, or low-frequency waves that humans do not hear and that would be generated following an explosion in the air, are monitored by sixty stations that are distributed around the globe.[49] These stations detect events such as meteorites, volcanoes, and bolides, in addition to atmospheric explosions. Infrasound technology was employed for a time in the 1960s and has generated a great deal of renewed interest in the scientific community since the advent of the IMS.

The three environments—earth, ocean, and atmosphere—have wave propagation, with the most rapid being through the interior of the earth. Placing the stations in the remote, quiet locations or in places needed for a fairly even distribution around the globe necessary for monitoring has provided a challenge. For example, infrasound stations have arrived on donkeys in the Chilean desert, and hydroacoustic cables have been laid on the Antarctic ocean floor, among others, which is accessible by boat only a few months of the year.[50]

The treaty provides for eighty radionuclide stations, half of which will also detect noble gases.[51] The gases may be detected if they escape from underground nuclear explosions, and they are referred to as the "smoking gun."[52] The radionuclide stations force high volumes of air through a filter paper to collect aerosol particulates in the atmosphere. Filters are changed regularly, and analysts examine the filters. Filters may be taken to one of the

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technologies-how-they-work/hydroacoustic-monitoring/page-5 (last visited Apr. 4, 2011).

48. *See* Dahlman et al., *supra* note 41, at 34–35; *FAQs*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/faqs/?uid=76&cHash=ff5d62bd7e (last visited Apr. 4, 2011).

49. *See* Elisabeth Blanc & Lars Ceranna, *Infrasound*, *in* SCIENCE FOR SECURITY: VERIFYING THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY 11, 12 (2009).

50. *See* Dahlman et al., *supra* note 41, at 34.

51. CTBT, *supra* note 15, protocol, pt. I(C).

52. *See* Dahlman et al., *supra* note 41, at 30; *see also Radionuclide Data Processing and Analysis*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/verification-regime/the-international-data-centre/radionuclide-data-processingand-analysis/page-1-radionuclide-data-processing-and-analysis (last visited Apr. 4, 2011).

sixteen laboratories certified by the treaty for examination. Noble gas detectors absorb mostly xenon isotopes on filters which are also analyzed on a regular basis. The CTBT IMS monitoring stations detected radioactive materials in Japan within a day after the March 11, 2011 earthquake and tsunami that damaged the Fukushima Daichi power plant; more than thirty-five radionuclide stations provided information that followed the dispersion of the isotopes to eastern Russia, the west coast of the United States and the northern hemisphere, and by April 13, 2011 the radioactivity had spread to the southern hemisphere, including Australia and Papua New Guinea. A radionuclide noble gas station in Yellowknife, Canada detected the first DPRK nuclear test in 2006.

In order to process, analyze, report, and archive the data from all 321 stations, the treaty established an International Data Center ("IDC") that continuously collects data from the stations by satellite and other communications systems.[53] The IDC is located at the Provisional Technical Secretariat of the CTBTO Preparatory Commission ("PrepCom") in Vienna, where states members meet to oversee and direct the implementation of the treaty. The data from the stations is authenticated to make sure that they have not been manipulated. The IDC then sends a compiled event bulletin containing data from the stations to the member states. Several gigabytes of data from IMS stations are sent to the IDC in Vienna every day. In addition to automatic processing, trained analysts review about 160 events each day, which include earthquakes, mining and other explosions. The events that are not clearly screened out or are identified as man-made are listed in a standard screened event bulletin as potentially suspicious.[54] Every day the IDC sends via satellite and other means of communication the event bulletin to member states. While this system is automated, human analysts are essential to the process of analysis and to check that important events are not ignored. The IDC detected the first "DPRK" test in 2006 with twenty-two seismic stations, and more than sixty seismic

53. CTBT, *supra* note 15, protocol, pt. I(F)

54. *See Waveform Data Processing and Analysis*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/verification-regime/the-international-data-centre/waveform-data-processing-and-analysis/page-2-waveform-data-processing-and-analysis (last visited Apr. 4, 2011).

stations detected the second test in 2009. In this instance, had the treaty been in force, an on-site inspection ("OSI") would have been helpful to locate the second test.[55]

The negotiators designed the system to be sensitive in the regions of the former test sites Novaya Zemlya in Russia, Nevada in the United States, and Lop Nor in China.[56] Most experts believe that the system will detect with a high degree of confidence a militarily significant nuclear test.[57] Experts who have been involved in the implementation of the IMS say that it is able to see down to a magnitude of 3.2 to 3.4 in the northern hemisphere with a ninety percent probability.[58] This is almost a factor of ten below a magnitude 4.0 disturbance like a small earthquake, which equates to a one-kiloton explosion. In certain places the system can detect explosions as small as ten tons, according to some experts.[59] Compared to ten years ago, "significant progress has been made in . . . detection, location, and identification"; and similar advances are expected in the next decade.[60] An International Scientific Study conducted from 2008 to 2009 found that technological advances in recent years have increased the possibilities of detecting even small nuclear tests.[61]

Should a state party have a concern about possible noncompliance, it may request a consultation and clarification process, and it may request an OSI.[62] At least thirty of the fifty-one members of the Executive Council must vote for the

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55. *See Experts Sure About Nature of the DPKR Event*, CTBTO PREPARATORY COMM'N (June 12, 2009), http://www.ctbto.org/press-centre/highlights/2009/experts-sure-about-nature-of-the-dprk-event.

56. *See 1994–96: Monitoring and Inspection*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/the-treaty/1993-1996-treaty-negotiations/1994-96-monitoring-and-inspection/page-1-1994-96-monitoring-and-inspection (last visited Apr. 4, 2011).

57. *See Tremendous Progress in the Build-up of the CTBT's Verification Regime*, CTBTO PREPARATORY COMM'N (Apr. 28, 2009), http://www.ctbto.org/press-centre/highlights/2009/fact-sheet-tremendous-progress-in-the-build-up-of-the-ctbts-verification-regime.

58. *See, e.g.*, Kathy Sawyer, *Experts Say New Sensing Tools Could Help Ease Concerns on Nuclear Test-Ban Treaty*, AM. ASS'N FOR ADVANCEMENT SCI. (Aug. 10, 2009), http://www.aaas.org/news/releases/2009/0810testban.shtml.

59. *See id.*

60. LESLIE A. CASEY & W. RANDY BELL, NUCLEAR EXPLOSION MONITORING RESEARCH AND DEVELOPMENT ROADMAPS 4 (2010).

61. Nicholas Kyriakopoulos & Thierry Héritier, *System Performance*, *in* SCIENCE FOR SECURITY: VERIFYING THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY (2009).

62. *See* CTBT, *supra* note 15, art. IV(C).

inspection, which may not cover an area exceeding 1000 square miles.[63] Opponents of the treaty believe that the Executive Council will have a difficult, perhaps impossible, task to obtain the requisite number of votes because its six regional groups will vote together within their blocs and this will be a purely political exercise. In this connection, it should be noted that the members of the Executive Council are elected taking into account political and security interests, nuclear capabilities relevant to the treaty, the number of monitoring facilities in the IMS, expertise and experience in monitoring technology, and contribution to the annual budget.[64] Treaty supporters believe that states will base their decisions about whether to proceed with an OSI on objective, credible, authenticated evidence of noncompliance coming from information from the certified stations of the IMS. In addition, the state calling for the inspection can also provide national information provided by states, as discussed below. OSIs are to be conducted in a manner that will find the most information possible without infringing upon the inspected state party's sensitive facilities or confidential information not related to the purpose of the inspection.[65] This involves a complex set of provisions, including, "managed access," under which the inspected state may indicate restricted areas. These areas are not to exceed four square kilometers, with a total of fifty square kilometers of exclusion.[66]

Yet OSIs are intrusive. They may involve seismological monitoring for aftershocks, measurements of radioactivity on and below the surface; over-flights, visual inspection, photography, ground-penetrating radar, magnetic and gravitational field mapping, and, if necessary, drilling to obtain radioactive samples. An operational manual will include specifics about exactly where inspectors are permitted and prohibited from entering, what kinds of equipment they are allowed to carry, the procedures they must follow, the training they must receive, etc. A number of field exercises have been held in order to assist in the development of the OSI regime, most notably the Integrated

63. *Id.* art. II(C), protocol, pt. I(C).
64. *Id.*
65. *Id.* art. IV(D).
66. *See id.* protocol, pt. II(E).

Field Exercise in 2008 at Semipalatinsk, Kazakhstan.[67] This was a large logistical effort for a relatively small organization, and it involved bringing more than fifty tons of equipment for five weeks to the experiment site, where some 200 people worked on ten different technologies in harsh, cold conditions.[68]

The results of exercises and work on the elaboration of an OSI operational manual, training, and other aspects of the development of the OSI regime are rather mixed: the work has progressed slower than expected because of the extremely sensitive aspects of inspecting a country's facilities; the United States, which has extensive experience and technological capabilities in this area, did not participate in the efforts for eight years (2001–2009); and there has not been a sense of urgency because an OSI cannot take place until the treaty enters into force.[69] The United States rejoined the efforts in 2009 by sending numerous experts to the meetings in Vienna, and experts believe that the terms to be included in an on-site manual could be finalized within a year, given the political and financial resources.

In addition to the monitoring capabilities of the IMS, states have their own national technical means ("NTM") that they can submit in the case of concern over noncompliance. NTMs can include satellites, aircraft and additional monitoring stations that are not part of the IMS, in particular some 15,000 seismic stations around the world, and other intelligence-gathering mechanisms.[70] The negotiators considered including the use of satellites in the CTBT verification regime; however, it was determined that this would be too costly.[71] Satellites of states may be equipped with optical bhang meters to detect optical signals from atmospheric explosions, as well as sensors that detect x-rays, gamma rays, neutrons, and electromagnetic pulses. Some

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67. *See* Press Release, CTBTO Preparatory Comm'n, Integrated On-Site Inspection Exercise in Kazakhstan Reaches a Successful Conclusion (Oct. 9, 2008), *available at* http://www.ctbto.org/press-centre/press-releases/2008/integrated-on-site-inspection-exercise-in-kazakhstan-reaches-a-successful-conclusion/?Fsize=yyeojlifzwieup.

68. *See id.*

69. *The Final Verification Measure*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/verification-regime/on-site-inspection/the-final-verification-measure/page-2 (last visited Apr. 4, 2011).

70. CTBT, *supra* note 15, art. IV(A).

71. *1994–1996: Reaching Critical Mass*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/verification-regime/building-theinternational-monitoring-system/1994-1996-reaching-critical-mass/page-3 (last visited Apr. 4, 2011).

countries have been working on a more recent technology, Interferometric Synthetic Aperture Radar ("InSAR"), which can detect small changes in the topography or subsidence in the earth after a nuclear explosion detonated at a depth of 600 meters or more at the Nevada Test Site.[72] It has the potential to detect underground facilities such as tunnels that could be associated with preparations for a nuclear test. Experts believe that InSAR could be used to locate an event within 100 meters, and thus this could assist OSI teams to find the correct location so that they could collect radioactive and other evidence of a nuclear test.[73] In the event of a clandestine nuclear test explosion, there is usually some evidence of the preparations for the test. The eventual appearance of noble gases is also possible.

Thus, states can use NTMs and the IMS synergistically in order to augment their monitoring capabilities. They could also cooperate in data collection and monitoring efforts. A cheater would not know, therefore, exactly how robust the verification capabilities are in a given site and could stand a large chance of being caught; this creates a strong deterrent effect in the treaty.

The assessment of compliance of a state party is a political process, and the negotiators insisted that the states, rather than the Technical Secretariat, should make the judgment regarding whether a state is in noncompliance with the treaty. States will base their judgment on IMS data, information from the IDC, or their NTMs, such as information from their own national monitoring networks or satellites. Following an OSI, each state party will analyze the data contained in the reports of the inspection team and decide for itself, or in conjunction with other states, whether the inspected state was in compliance with the treaty.[74]

By way of comparison, a number of other arms control treaties contain few if any provisions for verification. Efforts to develop a verification protocol for the Biological Weapons Convention ("BWC") were rejected after six years of

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72. Gabriele Rennie, *Monitoring Earth's Subsurface from Space*, SCI. & TECH. REV., Apr. 2005, at 5, 10.

73. *Id.*

74. *See* CTBT, *supra* note 15, art. IV(D).

negotiations.[75] The Strategic Offensive Reductions Treaty has no verification provisions; the five treaties establishing NWFZs in Africa, Central Asia, Latin America, South East Asia, and the South Pacific contain no functions requirements beyond IAEA safeguards (and for the Central Asia zone, the IAEA Additional Protocol is required).[76] while the PTBT relied on NTMs.[77] The NPT incorporates International Atomic Energy Agency ("IAEA") safeguards that may be strengthened by an additional protocol.[78] The Chemical Weapons Convention ("CWC") conducts routine inspections and provides for challenge inspections that will proceed unless blocked by a seventy-five percent vote in the Executive Council; this procedure has never been employed.[79] Other bilateral treaties between the United States and Russia, have extensive verification provisions, for example, the Intermediate-Range Nuclear Forces Treaty ("INF"), Treaty on the Reduction and Limitation of Strategic Offensive Arms ("START"), and New START.[80]

The PrepCom was established in 1996 to implement the monitoring regime of the treaty in order to prepare for entry into force.[81] It includes a Provisional Technical Secretariat to carry out the tasks mandated by the member states that meet several times a year in two different Working Groups.[82] One Working Group considers administrative and legal issues and the

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75. *See Biological Weapons Convention Background Information*, U.N. OFFICE AT GENEVA, http://www.unog.ch/80256EDD006B8954/(httpAssets)/699B3CA8C061D490C1257188003B9FEE/$file/BWC-Background_Inf.pdf (last visited Apr. 4, 2011).

76. *See supra* note 15 and accompanying text.

77. *See Limited Test Ban Treaty: Narrative*, U.S. DEP'T ST., http://www.state.gov/www/global/arms/treaties/ltbt1.html#1 (last visited Feb. 9, 2011).

78. NPT, *supra* note 25, art. III.

79. Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction art. IX, Jan. 13, 1993, S. Treaty Doc. No. 103-21, 1974 U.N.T.S. 45 [hereinafter Chemical Weapons Convention].

80. New START Treaty, *supra* note 39, art. V; Treaty between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms art. IX, U.S.-U.S.S.R., July 31, 1991, S. Treaty Doc. No. 102-20 [hereinafter START Treaty]; Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of their Intermediate-Range and Shorter-Range Missiles art. XII, U.S.-U.S.S.R., Dec. 8, 1987, S. Treaty Doc. 100-11 [hereinafter INF Treaty].

81. *Establishment, Purpose and Activities*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/the-organization/ctbto-preparatory-commission/establishment purpose-and-activities/page-1-establishmentpurpose-activities (last visited Apr. 4, 2011).

82. *Id.*

other focuses on building up the verification regime of the treaty. Upon entry into force, the PrepCom will become the CTBT Organization ("CTBTO"), composed of a Conference of States Parties (the principal decision-making organ that will meet annually), a technical secretariat, and an executive council (the executive body that will promote implementation and compliance with the treaty, including approving requests for OSI).[83]

The PrepCom has prepared the requisite operational manuals for seismological, radionuclide, hydroacoustic, and infrasound monitoring. These manuals, which regulate the technical operation of the IMS, in addition to the operational manual on OSI, will be adopted by the first Conference of the States Parties. The PrepCom will also report to the first conference on the readiness of the verification regime. Thus, the objective is a seamless transition from the PrepCom to a CTBTO that will be able to carry out the provisions of the treaty upon entry into force. The Provisional Technical Secretariat was established in 1997 and has been in operation longer than anticipated. External reviews of the organization and of the individual programs were conducted to cover the period from 2000 to 2005, and they presented substantive recommendations to improve the efficiency and financial operation of the organization.

III. *PROPONENTS AND OPPONENTS OF THE TREATY*

Two important reports within the United States evaluating the CTBT were produced in 2009, and they held different conclusions on the treaty. The Council on Foreign Relations favored ratification,[84] while the Congressional Commission on the Strategic Posture of the United States was not able to reach a consensus on the issue.[85] Another important report on the CTBT will soon be published by the National Academy of Sciences,

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83. *Entry into Force*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/the-organization/ctbto-after-entry-into-force/entry-into-force (last visited Apr. 4, 2011).

84. COUNCIL ON FOREIGN RELATIONS, *supra* note 7, pmbl.

85. *See* WILLIAM J. PERRY ET AL., AMERICA'S STRATEGIC POSTURE: THE FINAL REPORT OF THE CONGRESSIONAL COMMISSION ON THE STRATEGIC POSTURE OF THE UNITED STATES 81 (2009).

updating the study conducted in 2002,[86] and a National Intelligence Estimate has also been produced.

In the Congressional Commission Report, US opponents of the treaty argue that the verification provisions are not sufficient and that other countries might test without being detected.[87] They also believe that if the United States ratifies and the others do not, then it will be obligated to the treaty provisions and will not be able to test, while other countries might test.[88] Critics are also concerned about maintaining the safety and reliability of the nuclear weapons over time without nuclear testing. The US Stockpile Stewardship Program ("SSP") employs advanced computer modeling, examines fissile materials, and tests non-nuclear components of the bombs in order to maintain safety and reliability.[89]

Maintaining a safe and reliable stockpile of nuclear weapons without testing remains a challenge for the nuclear weapon states. The United States employs its Stockpile Stewardship Program that uses sophisticated computer modeling, tests the non-nuclear components (of which there are thousands), and studies fissile materials.[90] It also conducts subcritical tests, which use small amounts of fissile materials without creating a self-sustained chain reaction.[91] These types of tests have been conducted underground at the Nevada Test Site, Novaya Zemlya, and Lop Nor.[92] Another type of nuclear weapon related experiment is the hydrodynamic experiment, which does not use

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86. *Review and Update: Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty*, COMM. ON INT'L SECURITY & ARMS CONTROL, http://sites.nationalacademies.org/PGA/cisac/PGA_053215 (last visited Apr. 4, 2011).

87. *See* PERRY ET AL., *supra* note 85, at 84.

88. *See id.* at 83.

89. *See id.* at 81–82.

90. *See The Stockpile Stewardship and Management Program: Maintaining Confidence in the Safety and Reliability of the Enduring U.S. Nuclear Weapon Stockhold*, FED'N AM. SCIENTISTS (May 1995), http://www.fas.org/nuke/guide/usa/doctrine/doe/st01.htm.

91. *See generally* JONATHAN MEDALIA, CONG. RESEARCH SERV., RL 34394, COMPREHENSIVE NUCLEAR-TEST-BAN TREATY: ISSUES AND ARGUMENTS (2008).

92. *See* Andrew Kishner, *U.S. Conducts Subcritical Nuclear Test*, OPEDNEWS (Sept. 21, 2010), http://www.opednews.com/articles/U-S-CONDUCTS-SUBCRITICAL-by-Andrew-Kishner-100920-795.html; *Novaya Zemla Test Site To Be Maintained*, NUCLEAR THREAT INITIATIVE [NTI] (June 28, 2002), http://www.nti.org/db/nisprofs/russia/treaties/ctbt2.htm; *see also* Jeffrey Lewis, *"Subcritical Testing at Lop Nor,"* ARMSCONTROLWONK, Apr. 3, 2009, http://www.armscontrolwonk.com/2239/subcritical-testing-at-lop-nor.

fissile material.[93] Neither of these experiments are banned by the CTBT. On the other hand, hydronuclear experiments, which involve a small amount of fissile material that could result in "very slight degree of supercriticality," [94] are prohibited by the CTBT.[95]

A recent JASON study found that the primaries of most weapons systems in the US stockpile and of the plutonium pits in the nuclear bombs have a life span that exceeds 100 years,[96] and thus proponents of the treaty argue that the United States should not have a problem maintaining its stockpile under the treaty. Moreover, they contend that the CTBT would keep other countries from improving their arsenals, thus "locking in" the US advantage in this area.[97] Treaty supporters believe that without a test-ban treaty, nuclear programs of other countries pose a greater threat to US security than with a test-ban treaty because, without the treaty, other states could develop and test new or advanced weapons without limitations.[98] Critics, however, argue that it would not be wise to forever relinquish the option to test.[99]

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93. MEDALIA, *supra* note 91, at 21 n.76; *Nuclear Weapon Hydrodynamic Testing*, GLOBALSECURITY, www.globalsecurity.org/wmd/intro/hydrodynamic.htm (last visited Mar. 14, 2011).

94. ROBERT N. THORN & DONALD R. WESTERVELT, LOS ALAMOS NAT'L LAB., HYDRONUCLEAR EXPERIMENTS 1 (1987).

95. Suzanne L. Jones & Frank N. von Hippel, *Transparency Measures for Subcritical Experiments under the CTBT*, 6 SCI. & GLOBAL SECURITY 291, 292 (1997).

96. MITRE CORP., PIT LIFETIME REPORT 1 (2007), *available at* http://www.fas.org/irp/agency/dod/jason/pit.pdf.

97. *See* PERRY ET AL., *supra* note 85, at 82.

98. *See* Jennifer Weeks, *Nuclear Disarmament: Will President Obama's Efforts Make the U.S. Safer?*, CQ RESEARCHER, Oct. 2, 2009, at 813–36. Former director of Los Alamos National Laboratory Siegfried Hecker stated,

> The single most important reason to ratify the CTBT is to stop other countries from improving their arsenals—China, India, Pakistan, North Korea, and Iran if it ever progresses that far . . . . We gain substantially more from limiting other countries than we lose by giving up testing.

Id; *see Addressing the Threat*, CONSENSUS FOR AM. SECURITY, http://www.securityconsensus.org/addressing-the-threat (last visited Apr. 4, 2011). "The United States must lead the world in reducing the risks of nuclear proliferation to secure America, our allies and the international system." *Id.* America has the "modern and advanced techniques to ensure the safety and reliability of our nuclear arsenal. . . . We need to enforce a global standard against nuclear testing to inhibit hostile regimes from developing nuclear weapons." *Id.*

99. *See* Jon Kyl, U.S. Senator, Keynote Address at 2011 Carnegie Int'l Nuclear Policy Conference (Mar. 29, 2011) (transcript available at http://carnegieendowment.org/files/Senator_Jon_Kyl.pdf).

While a state that wants to develop nuclear weapons might not need to conduct a test to build a simple bomb, testing would be required to build more complex weapons. A report by General John Shalikashvili, former Chairman of the Joint Chiefs of Staff, concluded that the CTBT would enhance US security because of the United States' conventional military superiority, extensive nuclear testing experience, and advantages in stockpile stewardship capability.[100] The report also pointed out that other states that conducted tests below the detection threshold could not advance their nuclear weapons capabilities, and above that threshold, the verification capabilities were better than the opponents thought.[101]

IV. *THE SCOPE OF THE TREATY*

Another contentious issue in the US debate over ratification of the treaty revolves around the fact that although the P5 negotiators agreed that the CTBT should be a zero-yield treaty, this limitation is not stated in the treaty text. While the negotiations in Geneva were in a multilateral forum, the P5 conducted among themselves discussions on the side about the scope of the ban. This continued for some time during the negotiations, but the five finally agreed on a zero yield, and each of them announced this in the Conference on Disarmament.[102]

Nevertheless, opponents believe that Russia and possibly China are carrying out low-yield tests and that this could give them a substantial advantage in enhancing their nuclear weapons, which would result in a military advantage over the United States.[103] They also point to possible evasion scenarios such as decoupling of underground nuclear tests (which would

100. Letter and Report on the Findings and Recommendations Concerning the Comprehensive Nuclear Test Ban Treaty from John M. Shalikashvili, U.S. General, to William Clinton, U.S. President (Jan. 4, 2001), *available at* http://www.state.gov/www/global/arms/ctbtpage/ctbt_report.html.

101. *Id.*

102. *See* JAAP RAMAKER, JENIFER MACKBY, PETER D. MARSHALL, & ROBERT GEIL, PREPARATORY COMM'N FOR THE CTBTO, THE FINAL TEST: A HISTORY OF THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY NEGOTIATIONS (2003).

103. *See* PERRY ET AL., *supra* note 85, at 83.

take place in large underground cavities to reduce the seismic signal).[104]

The 1999 testimony of Ambassador Stephen Ledogar, chief US negotiator for the CTBT, revealed that

> [i]n the confidential negotiations among the five nuclear weapon states that went on the entire time the broader CTBT negotiations continued, it was clearly understood . . . that the boundary line—the 'zero line' between what would be prohibited to all under the treaty and what would not be prohibited—was precisely defined by the question of nuclear yield or criticality.[105]

Thus, there cannot be any critical yield from a nuclear event. Describing the negotiations in Geneva, Ambassador Ledogar said, "As the arcane and jargon filled complexities of the nuclear testing communities in Novaya Zemyla, Lop Nor, Mururoa, and Nevada became more widely understood, the nonnuclear states and broad public opinion increasingly insisted that the five should be allowed no tolerance—not even for the smallest possible nuclear yields."[106]

In the same hearing, former Secretary of State Madeleine Albright stated that the consultations among the nuclear weapon states led to the achievement of a shared understanding that "all nuclear explosions, however small, including low-yield hydronuclear tests, are prohibited, and subcritical experiments are not prohibited."[107] When asked by Senator Gordon Smith if the Russians have the same interpretation of zero yield as the United States, Secretary Albright answered, "Yes. We went through a negotiating process on this. That is correct, yes."[108] Undersecretary of State John Holum also confirmed at the hearing that the CTBT banned any nuclear test explosion or any other nuclear explosion, meaning "there cannot be any critical yield from a nuclear event."[109] He said, "You can do things that

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104. *Id.*

105. *Final Review of the Comprehensive Test Ban Treaty: Hearing before the S. Comm. on Foreign Relations*, 106th Cong. 17–18 (1999) [hereinafter *CTBT Hearing*] (statement of Ambassador Stephen J. Ledogar, Chief US Negotiator of the CTBT).

106. *Id.* at 21.

107. *CTBT Hearing*, *supra* note 105 (statement of Madeleine K. Albright, US Secretary of State).

108. *Id.* at 78.

109. *Id.* at 99 (statement of Undersecretary of State John Holum).

do not go critical; you cannot do things that do."[110] He also confirmed that the United States was conducting the same subcritical experiments as the Russians.[111]

In a recent article, one of the key Russian negotiators of the CTBT suggested that because ratification by the United States is in Russia's interests, there should be a possibility of confirming the 2000 official Russian position in the treaty by the State Duma that "all test explosions of nuclear weapons are banned, including so-called 'hydronuclear experiments,' whatever the level of energy released."[112] He also reiterated Russia's 2001 proposal to develop with the United States "additional measures to build trust and improve transparency with regard to activity on nuclear test sites."[113]

In 2001, General Igor D. Sergeev, Russia's adviser to former President Vladimir Putin on strategic stability, stated, "The unprecedented international verification mechanism being developed under the CTBT and the available modern national means of monitoring make it absolutely impossible to hide any violation of the Treaty."[114] Reading a letter from President Putin, he suggested the possibility of elaborating additional monitoring measures for nuclear test sites "going far beyond Treaty provisions. This could include the exchange of geological data and results of certain experiments, installation of additional sensors, and other measures."[115] Mr. Slipchenko proposed the possibility of beginning talks on this question soon, without waiting for the CTBT to enter into force.[116] He also suggested offering economic cooperation with India and Iran to encourage them to sign and ratify the treaty.[117] Current Russian President Dmitry Medvedev has confirmed that "[u]nder the global ban on

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110. *Id.*

111. *Id.*

112. Viktor Slipchenko, *Some Considerations Regarding the Ratification of the CTBT by the United States*, CARNEGIE MOSCOW CTR. (July 24, 2009), http://www.carnegie.ru/publications/?fa=40415.

113. *Id.*

114. Igor D. Sergeev, Assistant of President of the Russ. Fed'n on Strategic Stability, Statement at the Second Conference Facilitating Entry into Force of the Comprehensive Nuclear-Test-Ban-Treaty (Nov. 11, 2001) (transcript available at http://www.un.org/webcast/ctbt/statements/russiaE.htm).

115. *Id.*

116. Slipchenko, *supra* note 112.

117. *Id.*

nuclear tests, we can only use computer-assisted simulations to ensure the reliability of Russia's nuclear deterrent."[118]

On October 23, 1995, Russian President Boris Yeltsin and the United States' President William Clinton met in Hyde Park, New York, and President Clinton announced that he and President Yeltsin agreed that they would conclude a zero-yield comprehensive test ban treaty the next year.[119] On April 21, 1996, following a meeting of the G8 in Moscow, President Yeltsin said, "All, to the very last one, agreed that this year we've got to sign the treaty on banning and testing in any size of test forever . . . ." President Clinton added,

> We have all agreed to go with the so-called Australian language which is a strict zero-yield comprehensive test ban treaty. That is the only kind of treaty that can give the people of the world the certainty that they really are seeing the end of the nuclear age of the big weapons.[120]

The Australian delegation played a leading role in the formulation and promotion of the language on scope that was finally adopted in the treaty. The chief Australian negotiator, Ambassador Richard Starr, confirmed that discussions held in capitals of the five nuclear weapon states were "on the basis of a clear understanding" that the Australian language meant zero yield.[121] The Non-Aligned Movement had a similar understanding, as expressed by Indonesia on their behalf at the third session of the 2010 NPT Preparatory Committee: "We support the objective of the CTBT, which is intended to enforce a comprehensive ban on all forms of nuclear tests without exception, and to stop the development of nuclear weapons, in the direction of the total elimination of nuclear weapons."[122]

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118. *Russia to Use Supercomputers to Test Viability of Nuclear Arsenal*, GLOBAL SECURITY NEWSWIRE, (July 23, 2009), http://gsn.nti.org/gsn/nw_20090723_5131.php.

119. William Clinton, U.S. President and Boris Yeltsin, Russ. President, News Conference in Hyde Park, New York (Oct. 23, 1995) (transcript available at http://www.presidency.ucsb.edu/ws/index.php?pid=50688).

120. William Clinton, U.S. President and Boris Yeltsin, Russ. President, Press Conference at the Kremlin in Moscow, Russia (Apr. 21, 1996) (transcript available at http://www.fas.org/spp/starwars/offdocs/w960421b.htm).

121. Interview with Richard Starr, Chief Negotiator, Austl. (Jan. 31, 2011).

122. The Delegation of Indon. on behalf of the Grp. of Non-Aligned States Parties, Statement to the Third Session of the Preparatory Committee for the 2010 NPT Review Conference (May 7, 2009).

While treaty opponents believe that it is impossible to verify a zero-yield ban and that countries could conduct low-yield tests without being detected, treaty supporters maintain that the CTBT is effectively verifiable and that potential violators would extract little, if any, military value from clandestine testing at levels that are undetectable.

V. *BRIEF HISTORY OF NUCLEAR TESTING*

Some 2052 nuclear test explosions were carried out for more than fifty years in the atmosphere, under water, outer space, and underground.[123] They were detonated in more than twenty three locations around the world, and the majority, 1500, were conducted underground.[124] Most of them were conducted by the United States and the former Soviet Union—China conducted 45 tests; France 210; the Soviet Union 715; the United Kingdom 45; and the United States 1032.[125] Pakistan and India have claimed that they conducted five tests each (although there are questions regarding the actual numbers); North Korea has tested twice and Israel is not believed to have tested.[126] Most of those conducted by the United States were to research and refine new nuclear weapons or to study weapons effects.[127] Others were detonated for safety experiments, storage, and transportation, joint tests with the United Kingdom, and peaceful purposes (e.g., large engineering and construction projects).

The Russian Federation and the United States declared a moratorium in 1992, and they were joined by China and France in 1996, during the last year of the negotiations on a test-ban treaty.[128] The United Kingdom tested at the US nuclear test site

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123. FRANK BARNABY, HOW TO BUILD A NUCLEAR BOMB AND OTHER WEAPONS OF MASS DESTRUCTION 82 (2004).

124. OLA DAHLMAN ET AL., NUCLEAR TEST BAN: CONVERTING POLITICAL VISIONS TO REALITY (2009).

125. BARNABY, *supra* note 123, at 82.

126. *See id.*; JONATHAN MEDALIA, CONG. RESEARCH SERV., RL 41160, NORTH KOREA'S 2009 NUCLEAR TEST: CONTAINMENT, MONITORING, IMPLICATIONS 1 (2010).

127. *See* NEV. OPERATIONS OFFICE, U.S. DEP'T OF ENERGY, U.S. NUCLEAR TESTS: JULY 1945 THROUGH SEPTEMBER 1992, at vii (2000), *available at* http://www.nv.doe.gov/library/publications/historical/DOENV_209_REV15.pdf.

128. *Ending Nuclear Testing—International Day against Nuclear Tests*, UN, http://www.un.org/en/events/againstnucleartestsday/history.shtml (last visited Feb. 9, 2011).

and it has not tested since 1992.[129] In the United States, the National Nuclear Security Administration is required to certify that the country's warheads do not need testing for purposes of safety and reliability.[130] The many non-nuclear components are tested and replaced, and computer simulations as well as non-nuclear experiments are carried out to assist in the Stockpile Stewardship Program.[131]

VI. *HOW MUCH VERIFICATION?*

It is difficult to make an overall assessment of how much verification is sufficient for any given treaty. Experts recognize that there is no guarantee of 100% verifiability, no matter how many stations are erected. In 1992, Paul Nitze, the chief US negotiator of the Intermediate Range Nuclear Forces Treaty, defined effective verification: "If the other side moves beyond the limits of the treaty in any militarily significant way, we would be able to detect such violations in time to respond effectively and thereby deny the other side the benefit of the violation."[132] Thus, militarily significant cheating should be detected before it might threaten national security.

The IMS is meant to provide all states parties the possibility to monitor the CTBT. Even states parties that do not have the resources or national monitoring capabilities are provided data and event bulletins from the IDC, as well as a certain amount of technical assistance with their national authorities established to handle issues regarding the CTBTO. States can also request data from the IMS auxiliary stations.[133] In addition, in the last ten years the number of high quality seismic stations around the globe that are not part of the IMS has significantly increased.[134]

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129. *See Britain's Nuclear Weapons—British Nuclear Testing*, NUCLEAR WEAPON ARCHIVE, http://nuclearweaponarchive.org/Uk/UKTesting.html (last updated Aug. 23, 2007).

130. *See generally* Jeffrey Lewis, *After the Reliable Replacement Warhead: What's Next for the U.S. Nuclear Arsenal?*, ARMS CONTROL TODAY, Dec. 2008, at 18.

131. *See Stockpile Stewardship Program Fact Sheet*, U.S. DEP'T OF ENERGY NEV. SITE OFFICE, (Aug. 2010), http://www.nv.doe.gov/library/factsheets/DOENV_1017.pdf.

132. S. EXEC. REP. NO. 102-53, at 27 (1992).

133. *See* Bharath Gopalaswamy, *CTBT Verification: A System of Ties*, CTBTO SPECTRUM, Nov. 2010, at 16.

134. *The Role of Non-IMS Stations in Explosion Monitoring*, INT'L SEISMIC CENTRE, http://www.isc.ac.uk/doc/analysis/2003p08 (last visited Apr. 4, 2011).

This enables states to use data from IMS stations and others that are well placed to monitor a particular state or area of concern, assuming they have the ability to analyze the data.

While some countries take an active interest in monitoring the globe for nuclear testing and devote a large amount of effort and resources to it, many countries of the world are not very concerned about nuclear weapon test explosions and for them the CTBT holds little import. Each country will decide on its level of participation in the treaty, although it is the states parties—not the technical secretariat—who will make judgments about the verification of compliance. Thus they may be called upon to take part in such decisions and will need to understand the basis of the treaty.

Furthermore, states are likely to be interested in certain areas where they believe a nuclear test might take place, rather than the entire planet. A state could concentrate on selected information from the bulletin of IDC data regarding specific areas of concern to it. A state could obtain additional seismic data from stations outside of the IMS and certain high resolution satellite observations that are commercially available but not part of the IMS, as well as human intelligence. If it had the means, it could also install additional radionuclide stations for its own national use to increase local detection capabilities. This would require a certain amount of expertise and resources, however, in this way a state or group of states could enhance their capability to monitor and analyze the areas of concern to them.

An International Scientific Study to evaluate the capabilities of the CTBT verification regime was conducted by hundreds of scientists around the world from 2008 to 2009.[135] They presented their findings at a conference in June 2009, attended by 600 people from ninety countries, including scientific experts, diplomats and academics.[136] The CTBT monitoring stations have shown that they produce high-quality data and, with the dramatic technological and scientific developments that have taken place

135. *See generally* INTERNATIONAL SCIENTIFIC STUDIES CONFERENCE, SCIENCE FOR SECURITY (2009).

136. *See Scientific Contributions*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/specials/the-international-scientific-studies-project-iss/scientific-contributions (last visited Apr. 4, 2011).

since the treaty was negotiated, their capabilities are greater than expected by the designers of the system.

VII. *ENTRY INTO FORCE*

Although the verification machinery required to monitor the CTBT is eighty percent installed,[137] and as mentioned, 153 countries have ratified the treaty,[138] entry into force is still proving to be problematic.

Some have asked whether the countries still needed to ratify the treaty for it to enter into force, such as North Korea and Iran, will ratify the treaty even if the United States ratifies. "U.S. ratification is a critically needed circuit-breaker: it would have an immediate impact on other holdout states, and add major new momentum to both disarmament and non-proliferation efforts."[139] This may seem overly optimistic; however, international norms impose a powerful influence on states.[140] International instruments and pressures have helped prevent a number of countries from acquiring nuclear weapons.

Regarding the other holdouts referenced above, Indonesia had stated that it would ratify as soon as the United States becomes a state party; however, it announced at the May 2010 Review Conference of the Nuclear Nonproliferation Treaty that it would proceed to ratify on its own.[141] Indonesia signed the treaty the day it was opened for signature, and its six auxiliary seismic stations in the IMS are all certified.[142]

It is widely believed that China will ratify the treaty soon after the United States. Like the other P5 countries, China signed the treaty the day it opened for signature, and the treaty has been

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137. *See* Press Release, Comprehensive Test Ban Treaty Org., A Decade of "Remarkable Achievements" in Advancing the CTBT (Nov. 9, 2010).

138. *Id.*

139. GARETH EVANS & YORIKO KAWAGUCHI, INT'L COMM'N ON NUCLEAR NON-PROLIFERATION AND DISARMAMENT, ELIMINATING NUCLEAR THREATS: A PRACTICAL AGENDA FOR GLOBAL POLICYMAKERS 103 (2009).

140. *See* Michael O'Hanlon, *Resurrecting the Test Ban Treaty*, SURVIVAL: GLOBAL POLITICS & STRATEGY, Feb. 2008, at 119, 125 (2008).

141. *See* Sean Dunlop & Gaukhar Mukhatzhanova, *Indonesia Takes the Lead on the CTBT*, JAMES MARTIN CTR. FOR NONPROLIFERATION STUDIES (May 4, 2010), http://cns.miis.edu/stories/100504_indonesia_ctbt.htm.

142. *See CTBT Signatories*, *supra* note 11; *see also CTBT Station Profiles*, CTBTO PREPARATORY COMM., http://www.ctbto.org/verification-regime/station-profiles [hereinafter *CTBT Station Profiles*] (last visited Apr. 4, 2011).

awaiting ratification in the National People's Congress for ten years.[143] China was active in the negotiations in the CD and has participated in the work of the CTBT PrepCom, including on OSI.[144] A high level Chinese diplomat in Vienna said, "China fully cherishes the international norm that any nuclear test after the CTBT is a violation, including for those countries outside of the CTBT."[145] China has thirteen IMS facilities, most of which are in the operational or testing phase.[146]

In 1954 Indian Prime Minister Jawaharlal Nehru became the first to call for a nuclear test ban.[147] India has supported the elimination of nuclear weapons for many years and participated dynamically in the negotiations in Geneva, serving as Friend of the Chair on verification and legal issues.[148] However, the treaty did not include India's call for a time-bound framework for nuclear disarmament and did include India on the list of countries required to ratify for entry into force. India responded by withdrawing its four monitoring stations from the IMS and declaring that it would not approve the treaty in the CD.[149] Shortly thereafter, in 1998, India and Pakistan conducted a series of nuclear tests.[150] India has since observed a moratorium on testing, and this is considered a condition of the United States for cooperation on the civil nuclear agreement of 2006.[151]

In 1999 Indian Prime Minister Atal Behari Vajpayee told the United Nations General Assembly that India would "not stand in

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143. *See CTBT Signatories, supra* note 11; *Comprehensive Test Ban Treaty (CTBT)*, NTI, http://www.nti.org/db/china/ctbtorg.htm (last visited Apr. 4, 2011).

144. *See generally* Ambassador Hu Xiaodi, Head of Chinese Delegation, Address at the 33rd Session of the PrepCom for CTBTO (Nov. 16, 2009).

145. Interview with Chinese Diplomat.

146. *See CTBT Station Profiles, supra* note 142.

147. *See History of Efforts for the CTBT*, PROJECT FOR THE COMPREHENSIVE NUCLEAR TEST BAN TREATY, http://www.projectforthectbt.org/history (last visited Apr. 4, 2011).

148. RAMAKER ET AL., *supra* note 102, at 269, 271.

149. *See 1994-1996: Debating the Basic Issues*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/the-treaty/1993-1996-treaty-negotiations/1994-96-debating-the-basic-issues/page-11994-96-debating-the-basic-issues (last visited Apr. 4, 2011); *1994-1996 Entry into Force Formula*, CTBTO PREPARATORY COMM'N, http://www.ctbto.org/the-treaty/1993-1996-treaty-negotiations/1994-96-entry-into-force-formula/page-3-1994-96-entry-into-force-formula (last visited Apr. 4, 2011).

150. *See* William J. Broad, *Explosion Is Detected by U.S. Scientists*, N.Y. TIMES, May 29, 1998, at A10.

151. *See* Amelia Gentleman, *India and U.S. Try to Rekindle Stalled Talks on a Nuclear Pact*, N.Y. TIMES, June 1, 2007, at A11.

the way" of the treaty coming into force.[152] Nevertheless, others are not so optimistic, in view of a strong public opinion attached to the nuclear capability. The four monitoring stations (primary and auxiliary seismic, radionuclide, and infrasound) that were to be located in India are currently listed as "to be determined" in the alphabetical spot where India would appear,[153] and many assume that they will revert to the list of IMS stations if and when India signs the treaty.

Pakistan was also active in the negotiations and has attended a number of meetings of the PrepCom and three of the bi-annual Conferences on Facilitating Entry into Force of the Treaty (Article XIV Conferences) as observer.[154] Pakistan has supported the conclusion of a test-ban treaty for many years, and voted for the treaty at the United Nations in 1996, unlike India.[155] It has also observed a moratorium on nuclear testing since its tests in 1998. It was thought that Pakistan would sign the treaty in tandem with India; however, Pakistan has recently claimed that the US-India nuclear deal has affected the imbalance in their capabilities and that it will act according to its own security interests.[156] Pakistan has a primary seismic and an infrasound station that are still in the planning stage.[157]

Israel also participated actively in the negotiations in the CD. As an observer it was not permitted to break consensus; however, it contributed papers and proposed language that were reflected in the treaty. It was especially interested in the provisions for on-site inspections, being concerned about the non-abusive nature of the OSI regime, equal status in the

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152. *See Seeing CTBT Through*, EXPRESS INDIA (May 6, 1999), http://www.expressindia.com/ie/daily/19990506/iex06062.html.

153. *Annex 1 to the Protocol*, FED'N OF AM. SCIENTISTS, http://www.fas.org/nuke/control/ctbt/text/artbyart/anx1_pro.htm (last visited Apr. 4, 2011).

154. *See* Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty, Vienna, Austria, Sept. 3–5, 2003, U.N. Doc. CTBT-Art.XIV/2003/5 (Sept. 11, 2003); Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Treaty, Vienna, Austria, Oct. 6–8, 1999, U.N. Doc. CTBT-Art.XIV/1999/5 (Oct. 8, 1999); *see also* Kaegan McGrath, *Entry into Force of the CTBT: All Roads Lead to Washington*, NTI, (Apr. 2008), http://www.nti.org/e_research/e3_entry_into_force_ctbt.html.

155. *See 1996: CTBT: A Long-Sought Success*, CTBTO PREPARATORY COMM., http://www.ctbto.org/the-treaty/1993-1996-treaty-negotiations/1996-ctbt-a-long-sought-success/page-1-1996-ctbt-a-long-sought-success (last visited Apr. 4, 2011).

156. Noor ul Haq, *Preface*, ISLAMABAD POL'Y RES. INST. [IPRI] FACTFILE, Apr. 2006.

157. *CTBT Station Profiles*, *supra* note 142.

Executive Council (which will make the decisions about OSI), and adherence to the treaty by other Middle Eastern states. As the Executive Council is composed of regional blocs, Israel is concerned that it will never be given a seat in the group encompassing the Middle East and South Asia. Although many do not think that this will prevent Israel from ratifying, Israel is unlikely to let its rights be compromised.[158] Israel continues to participate in the deliberations in the PrepCom, in particular on the OSI operational manual, training, and exercises.[159] It has two certified auxiliary seismic stations and a radionuclide laboratory on the IMS list.[160]

Iran served in the negotiations as Friend of the Chair on aspects of verification and on-site inspections.[161] It signed the treaty on the day it opened for signature, voted in favor of the CTBT resolution in 2009 and has engaged in the meetings of the PrepCom, in particular in the Working Group on Verification.[162] It has six stations in the IMS, one primary seismic station that has been certified, two auxiliary seismic stations in the testing phase, two planned radionuclide stations and a planned infrasound station. The controversy in the United Nations and the IAEA surrounding Iran's nuclear activities has influenced its participation in international discussions and may affect its path towards ratification of the CTBT. Iran contends that its activities are related to peaceful uses of nuclear energy, and has insinuated that it will link ratification to the CTBT with the establishment of

158. Interview with high level Israeli Diplomat.

159. *See* Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Teaty, New York, U.S., Sept. 21–23, 2005, *List of Participants at the Conference*, U.N. Doc. CTBT-Art.XIV/2005/INF.4 (Oct. 10, 2005); Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Teaty, Vienna, Austria, Sept. 17–18, 2007, *List of Participants at the Conference*, U.N. Doc. CTBT-Art.XIV/2007/INF.4 (Oct. 10, 2007).

160. *CTBT Station Profiles*, *supra* note 142.

161. *See* RAMAKER ET AL., *supra* note 102, at 270, 273.

162. *See CTBT Signatories*, *supra* note 11; *see also* Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Teaty, Vienna, Austria, Sept. 17–18, 2007, *List of Participants*, U.N. Doc. CTBT-Art.XIV/2007/INF.4 (Oct. 10, 2007); Conference on Facilitating the Entry into Force of the Comprehensive Nuclear-Test-Ban Teaty, New York, U.S., Sept. 21–23, 2005, *List of Participants at the Conference*, U.N. Doc. CTBT-Art.XIV/2005/INF.4 (Oct. 10, 2005); Recorded Vote in the General Assembly on *G.A. Res. 64/31*, U.N. OFFICE FOR DISARMAMENT AFFAIRS, http://unhq-appspub-01.un.org/UNODA/vote.nsf.

a Middle East zone free of weapons of mass destruction.[163] The argument has been made that if Iran is serious about its claim that it is not developing nuclear weapons, it would ratify the CTBT. It is one of the 118 members of the Non-Aligned Movement, which has voiced its support of the CTBT on a number of occasions.[164] At its 2009 summit, the Non-Aligned Movement ("NAM") stressed the significance of universal adherence to the CTBT.[165] Iran will chair the NAM in 2012.[166]

Egypt was also active in the CTBT negotiations and served as Chairman of the Working Group and moderator on legal issues.[167] It holds the view that it has been in good standing with the NPT, and until Israel ratifies the NPT to address what Egypt sees as an imbalance in regional nonproliferation and disarmament, it will not support further arms control agreements, including the CTBT, the Chemical Weapons Convention, the Pelindaba Treaty, or the IAEA Additional Protocol.[168] One of the priorities for Egypt is the establishment of a zone free of nuclear weapons and other weapons of mass destruction.[169] The provision for such a zone was encompassed in the decision taken in 1995 to extend the NPT indefinitely, and the NAM countries voice resentment that this provision has not been honored.[170] The 2010 NPT Review Conference decided to hold a conference in 2012 on a zone free of weapons of mass destruction in the Middle East,[171] and it remains to be seen how much progress will be made. Egypt's primary array and auxiliary

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163. Interview with high level Iranian Diplomat.

164. *See The Non-Aligned Movement: Member States*, NON-ALIGNED MOVEMENT, http://www.nam.gov.za/background/members.htm (last visited Apr. 5, 2011).

165. *See Final Document*, XV Summit of the Heads of State and Government of the Non-Aligned Movement, July 11–16, 2009, *available at* www.namegyppt.org/en/RelevantDocuments/Pages/default.aspx.

166. *See Iran to Head NAM*, IRAN TIMES INT'L (Wash., D.C.), May 8, 2009, *available at* LEXIS.

167. *See* RAMAKER ET AL., *supra* note 102, at 271.

168. *See, e.g.*, Press Release, Egypt Ministry of Foreign Aff., Meetings of the Third Session of the Preparatory Comm. for the 2010 Non-Proliferation Treaty Review Conference (May 4, 2010), *available at* http://www.mfa.gov.eg/English/EgyptianForeignPolicy/InternationalOrgRelation/DisArm/Pages/DisArm452009nptnewyork.aspx.

169. *See Egypt: Nuclear Country Profile*, NTI, http://www.nti.org/e_research/profiles/egypt/nuclear (last updated Mar. 2011).

170. *See* 1995 Review and Extension Conference, *supra* note 17, at 13.

171. *See* 2010 NPT Review Conference, *supra* note 6, at 30.

seismic stations are planned but have not been installed.[172] A high-level diplomat said that Egypt might not install this key array until the prospects for entry into force are more positive.[173]

North Korea is very difficult to assess, due to its closed and secluded situation in the international arena. It participated in the negotiations and voted for the UN resolution that adopted the treaty.[174] It conducted two nuclear weapon explosions, in 2006 and 2009, and has not indicated plans in regard to the CTBT. This could be considered in the six-party talks, assuming they resume.[175] The DPRK test in 2006 was detected by twenty-two seismic stations of the IMS, even though its yield was only about 0.5 kilotons.[176] Additionally, the radionuclide station at Yellowknife, Canada detected xenon-133 coming from the test 7000 km away.[177] The analysis of data from IMS radionuclide stations is assisted by weather "backtracking" information, e.g., movement of atmosphere or wind patterns, which is supplied by the World Meteorological Organization.[178] Sixty-one seismic stations detected the slightly larger North Korean nuclear test of May 2009, although no radionuclides were detected in that instance.[179] There are no IMS stations to be installed in North Korea.[180]

The United States has five primary, twelve auxiliary, eight infrasound, two hydroacoustic and eleven radionuclide stations. All of them are certified except for three of the infrasound stations, which are in the planning stage.

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172. *CTBT Station Profiles*, *supra* note 142.

173. Interview with Egyptian Diplomat.

174. *CTBT Signatories*, *supra* note 11.

175. LARRY A. NIKSCH, CONG. RESEARCH SERV., RL 33590, NORTH KOREA'S NUCLEAR WEAPONS DEVELOPMENT AND DIPLOMACY 3 (2010).

176. *See* R. Le Bras et al., *CTBTO Seismic Processing and the Announced DPRK Nuclear Test of October 9, 2006*, 9 GEOPHYSICAL RES. ABSTRACTS (2007), http://meetings.copernicus.org/www.cosis.net/abstracts/EGU2007/07286/EGU2007-J-07286-2.pdf.

177. *The CTBT Verification Regime Put to the Test—The Event in the DPRK on 9 October 2006*, CTBTO PREPARATORY COMM., http://www.ctbto.org/press-centre/highlights/2007/the-ctbt-verification-regime-put-to-the-test-the-event-in-the-dprk-on-9-october-2006 (last visited Apr. 5, 2011).

178. CTBTO PREPARATORY COMM., ANNUAL REPORT 2006, at 22 (2007).

179. Press Release, CTBTO Preparatory Comm., Experts Sure about Nature of the DPRK Event (June 12, 2009), *available at* http://www.ctbto.org/press-centre/highlights/2009/experts-sure-about-nature-of-the-dprk-event.

180. *See, e.g.*, *CTBT Station Profiles*, *supra* note 145.

CONCLUSION

The Vienna Convention on the Law of Treaties requires states parties to a treaty to refrain from actions that would "defeat the object and purpose" of the treaty.[181] Thus far CTBT member states have not tested, even though the treaty has not entered into force. Nevertheless, entry into force would constitute a legally binding norm, while a moratorium constitutes an indeterminate status that could more easily be broken. Furthermore, not all countries have subscribed to a moratorium.

Academic and research experts have occasionally espoused theories about the possibility of provisional application of the CTBT as a last resort.[182] If the international community is blocked by a small number of intransigent states, it has been suggested that rather than wait for an indefinite period of time, the states parties could agree among themselves that the treaty has entered into force for them.[183] This would present many cumbersome legal, financial, and logistical questions relating to ownership of the stations, acquiring data from states not party to the treaty, recalculating the dues for each country, and other complex matters. Thus most experts have opposed the provisional entry into force, believing that it would provide a screen behind which nonparties could hide and delay the full entry into force indefinitely.[184] The idea was considered during the negotiations but has not been raised in the meetings of the PrepCom.

Given the political climate in the United States and the number of urgent matters competing for legislative action, it seems unlikely that President Obama will bring the treaty before the Senate in the near future. The implementation of the treaty's monitoring and verification regime can continue, although on-site inspections will not be possible until entry into force. It remains to be seen whether international attention will focus more on potential proliferation than on possible future testing. Although the predictions of the 1960s that there would soon be

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181. Vienna Convention on the Law of Treaties art. 18, May 23, 1969, 1155 U.N.T.S. 331, 8 I.L.M. 679.

182. *See* ANTHONY AUST ET AL., INT'L GROUP OF GLOBAL SECURITY, A NEW LOOK AT THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY (CTBC) 45–56 (2008).

183. *See id.*

184. *See id.*

many more nuclear weapon states has not come about, it is not clear whether the world is safer and more secure without a treaty that prohibits nuclear testing.